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THE MEN OF THE MID-PACIFIC

By ALFRED GOLDSBOROUGH MAYER

MORE than 2,000 years ago, there lived upon the Islands from Sumatra to the Philippines an ancient sea-faring race, the brown-skinned Sawaiori. Of their origin we know nothing, but that they had long been separated from the Indian Peninsula is evident, for there are no Sanscrit words in the language of their descendants.

Much as the Polynesians are to-day, their ancestors, the half-mythical Sawaiori, probably were in those ages long past, for even to-day no Polynesian population has developed a national solidarity. Their political and social unit is and always has been the village, fortified, self-centered, with no communal interest and no civic virtue extending beyond the limits of its ramparts of rattan.

Weak as a house divided against itself were the Sawaiori when before the dawn of our Christian era, hordes of Malay pirates began to swarm out from southeastern Asia and to overrun the off-lying islands.[1]

We may picture village after village obliterated in an orgie of massacre and outrage. From the roar of burning thatch the weak ones slunk away, while to the cat-like Malay the heroes fell a prey. One desperate resource remained to the persecuted race—flight over the wide and unknown waters of the Pacific.

Eastward went the fugitives in two great streams, one along the northern and the other skirting the southern coast of New Guinea.

But, although forced by hunger to conquer a landing place, there to grow the broad-leaved taro for the onward voyage, no home for the Sawaiori could be found upon New Guinea, for ever in his rear there lurked the Malayan prahu, while the forests around him secreted cannibals hungering for his flesh. Before the dawn of history they sailed, these mariners of a weak and exiled race, who heavy with many a fear the world has long outlived, yet braved the unknown perils of this loneliest of seas—the ocean of the long low heave, the never stilled breathing of the monster in his sleep; for calm over the Pacific has but the semblance

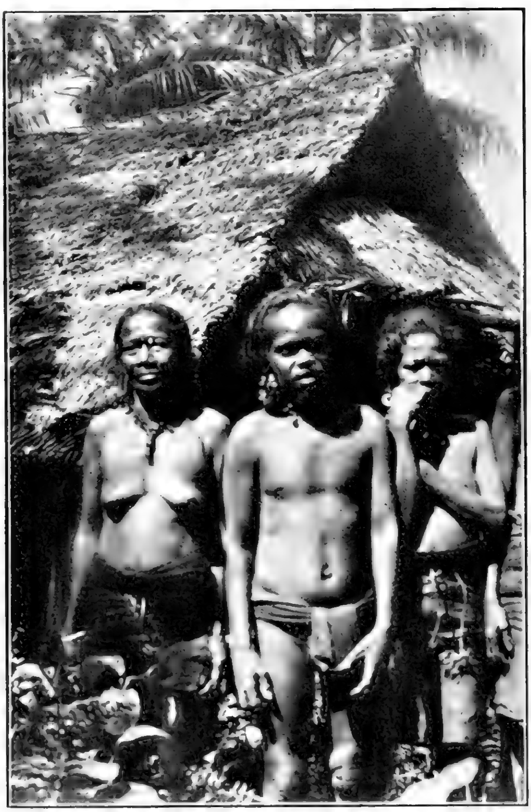
1 For a résumé of his own and previous researches upon this subject one should consult William Churchill's "Polynesian Wanderings," published by the Carnegie Institution of Washington in 1911.

of peace and over its hours of stillness there broods the threat of storm—to them but the inaction of a demon nursing his rage.

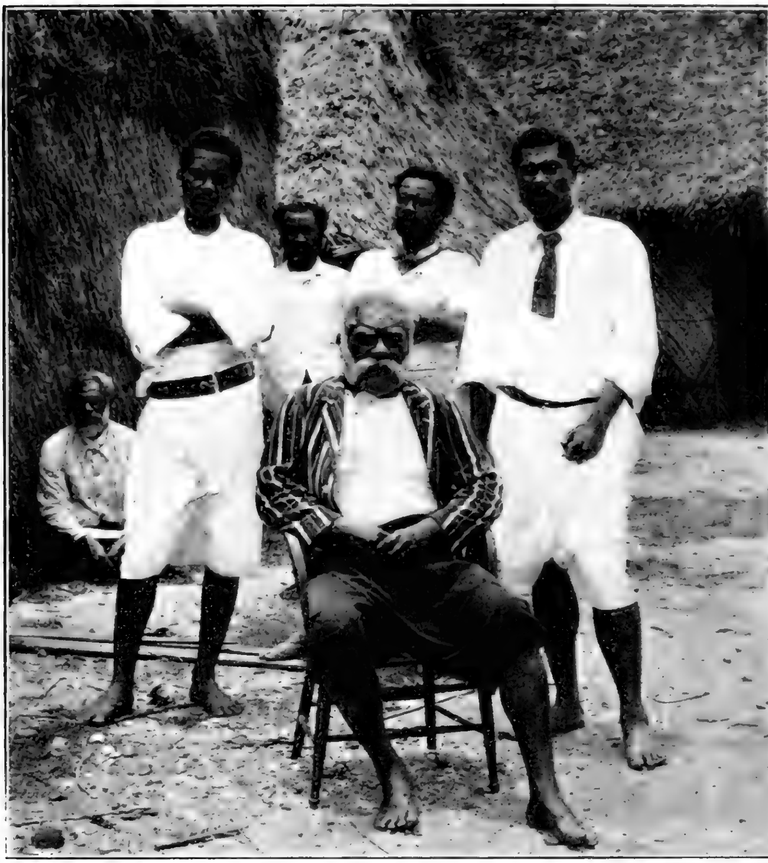
Thus onward sped the disheartened bands until New Guinea and the Bismarck Archipelago faded beneath the western sea, and the high mountains of the Salomons rose majestically above the eastern horizon. Then along the coast of these Islands, so fair to look upon, our wanderers still sailed searching always for the land of peace and finding only the abode of the Melanesian savage, but still beyond, luring them onward toward the rising sun, lay the untried ocean.

Forced at last to leave all land behind, they did as wise sailors would have done, steered close into the southeast trades that blow so constantly over this vast expanse of ocean. Thus when starvation hovered near, when the last of the meagre store of fermented bread fruit had been consumed, and slaves began to fall to sustain the master voyagers, there still remained as a last resource the fair wind to bear them back to the known but dreaded shores of the Salomons.

Such a course from the southeasternmost Salomons close hauled on



Natives of Truk Atoll, Caroline Islands.



KING AND HIGH CHIEFS OF FIJI, AT BAU, IN 1899.

the tropical wind, would carry our navigators to the Santa Cruz group where once again they had to encounter their old foe the negroid Melanesian. Thus after conquering only enough of the coveted shore to suffice for a temporary resting place, they sped onward and away to discover Rotumah where at last peace from all but their own ambitions awaited them.

Then as years passed and little Rotumah became overpopulated, and jealousies engendered savage wars, some long-forgotten Columbus of the Pacific made a last and final voyage of 600 miles over the open ocean to beautiful Samoa, the El Dorado of the Polynesian race.

With faces toward the rising sun they had gone their fearsome way, and as beaten fugitives taking awful chances a remnant of their race had found the seclusion of a land untrodden by any but their own feet. Yet, as men treasuring the memory of their past, they turned their homesick faces toward the setting sun, whence the spirits of their dead returned over the ocean to the mythical fatherland the old songs still de-

THREE MAIDENS OF FUNAFUTI ATOLL, ELLICE ISLANDS. Types of the Polynesian race.

scribe. For somewhere, far to the westward lay the half-forgotten home, and the something that stands for Europe to us in America, is the fabled Hawaiki to the Polynesians of to-day.

Generations came and passed, but Samoa remained to them by right of eminent domain. Yet history constantly repeats itself, and wars and persecutions again operated as of old, so that within historic times, from five hundred to three hundred years ago, so the old songs tell, great voyages were made from Samoa to Hawaii, to the Cook Islands and thence to New Zealand; to Tahiti, Fiji, Tonga, the Ellice and Gilbert Islands, and to the remotely isolated Easter Island. In Samoa the story is of the departing fugitives and in Hawaii or New Zealand the song tells of their arrival, and the dates of these achievements are fixed by the generations of the chiefs that have been and passed away, and are now but names known but to the chanting priests. For two thousand miles around Samoa the men of Polynesian race were masters of the island-world, and thus from Rotumah to Easter Island four thousand miles from west to east, and from New Zealand to Hawaii

four thousand miles from south to north, one general language is spoken even to our day.

Throughout this vast area, islands uninhabited to-day show crude carvings on the rocks, as at Pitcairn, evidencing the presence of voyagers long dead. There is reason to believe that for centuries before the white man came, the arts of canoe-making and sailing had been declining in Polynesia. Yet centuries

MAN OF TRUK GROUP, CAROLINE ISLANDS. Ear-rings made of turtle and snail shells. Malay admixture is apparent.

MAAFU MAATU, A HIGH CHIEF OF TONGA, nephew of Maafu, who conquered the Lau Group of the Fiji Islands.

before our ancestors dared venture from the sight of land, the Polynesians were lords of the vastest ocean empire of the earth.

Thus far, we have considered only the northern current of adventurers, those who sailed along the northern shore of New Guinea; but as Churchill shows, there were others, who, forced out from the region of Sumatra, wandered eastward along

A Warrior of Tari Tari Island, Gilbert Islands, dressed in cocoanut fiber armor and shark's skin belt, and holding weapons edged with shark's teeth.

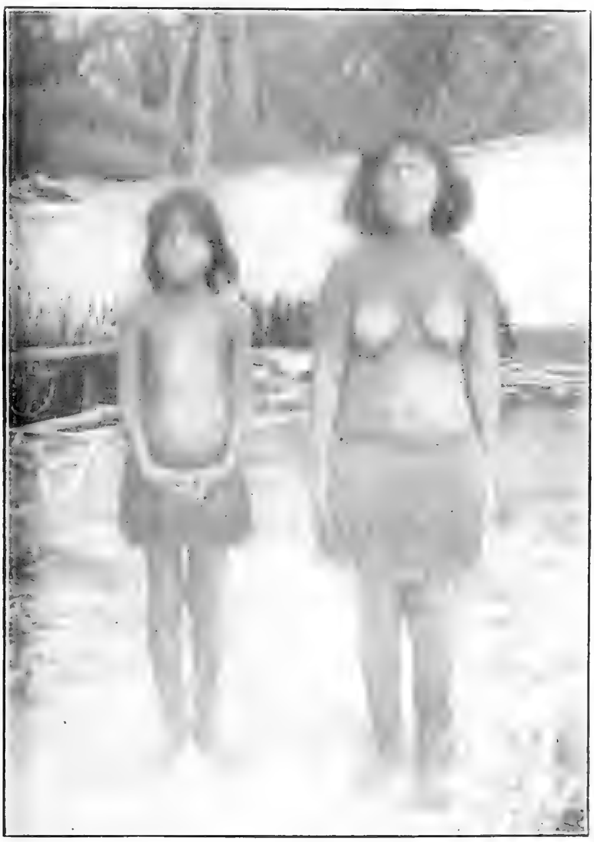
the southern shore of New Guinea until they reached the region of Torres Straits, where traces of their language still remain. Then, as they, too, sailed outward over the Pacific, certain of their canoes found a final resting place upon the New Hebrides, as at Efaté, Aniwa and Fotuna, where the negroid Melanesians still retain many Polynesian words and phrases; then, finally, these southern wanderers found Fiji, there to amalgamate with the more primitive Melanesians and to give rise to one of the finest races now inhabiting the Pacific.

As for the remnant of Sawaiori words now found in the speech of the Malays, it is such as one would expect the sons of conquerers to acquire from their mothers of the conquered race.

The purest examples of the Polynesian stock to be seen to-day are in Samoa, the Society, and Ellice Islands. The once superb men of New Zealand, and the giant race of Tahiti have degenerated, the population

of the Marquesas is upon the verge of extinction and the Hawaiians are declining and amalgamating with the Chinese.

In color the Polynesian is a rich bronze-brown, and when not sunburned he may be said to be about twice as dark as a Spaniard or Southern Italian. The black hair, slightly waving, falls in heavy masses over the fine broad shoulders. The somewhat flattened never prominent nose and chin are very characteristic. The lips are full but not protrusive, and the eyes are almond-shaped, giving so close a general resemblance to the Japanese peasant that one has difficulty in distinguishing one from the other when both are mingled in a crowd. The Polynesian is, however, far larger and more muscular in appearance than the Japanese and as he stands superbly erect, his shoulders never bent under the weight of servile burdens or stooped to the student's yolk of mental labor, one is forced to liken him to a bronze statue turned to life, so charming is the symmetry of his superb body. In contrast with the athletes of our own race, his chest-muscles are far finer, and instead of



MOTHER AND DAUGHTER, TARAWA ISLAND, GILBERT ISLANDS.

being good only in arms or legs his uniformity of development is remarkable. None of his muscles stands out in distorted swollen form, but all in all he is the epitome of graceful manly strength, not thin and cat-like as is the treacherous Malay.

In contrast with the Polynesian stands the Papuan of Eastern New Guinea for, despite his Polynesian admixture, in essential characteristics he remains negroid, with a huge mop-like mass of coarse crinkled hair. His skin is dark chocolate, his arms long, his poorly developed legs short and bent at the knees, and his body weakly made, his small eyes bloodshot and sinister, nose large but only moderately flattened, and the weak chin and thick protrusive lips revealing descent from Africa.

WOMAN SHOWING PIERCED EARS, AND MODE OF WEARING MATS. RONGELAB ATOLL, MARSHALL ISLANDS.

YOUTH OF ROGELAB ATOLL, MARSHALL ISLANDS, showing the mode of wearing the mat. Micronesian type.

In Fiji, and to a lesser degree in Tonga we find a mixed race with

the mop-like hair and small cruel eye of the Papuan, but with a splendidly developed body, the proud heritage from Polynesian ancestors. In Tonga and Fiji the average height is probably quite six feet, and the symmetry of form and perfection of development of every muscle in these huge but shapely men seem more statuesque than human to us, accustomed as we are to shoulders bent by the physical and mental tasks of civilization. "A Shrimp" the huge Fijian laughingly designates the white man, in allusion to his puny strength and stooping figure. It is a new thing to us, this sight of superb bronze-brown men and women, all unconscious of their scantiness of clothes, the most beautiful of all nature's children in their naturalness. Nor is it to be assumed that being unclothed is conducive to immorality, for the morals of a Fijian village would put those of our own towns to the blush.

In striking contrast to the finer races of the Pacific is the Australian who is among the lowest of existing men, apparently comparable in culture with the savage who lived in Europe before the Glacial epoch, and whose remains have occasionally been found in caverns as at Neanderthal and Spee. The lowest of the Australians are those of the vast spinifex deserts of the interior, while the highest in physique and culture are found in the tropical forests of Queensland or along the shores of the Northern Territory, where an admixture of Papuan blood has improved the race. But nowhere does the Australian rise to the intellectual level of the natives of the Pacific Islands. His little eyes glitter suspiciously from deeply sunken orbits nearly hidden under unkempt locks of matted hair that conceal the low retreating brow, furrowed and frowning. The dark chocolate color of his face with its huge flat nose, broad-lipped slit-like mouth, projecting teeth, and weak retreating chin form a demon-like picture as he skulks silent and snake-like through the thickets where he seeks the kangaroo. He wears no clothing, but for decoration he may carry a crude necklace of shells or seeds, and his body is seamed by the scars of deep cuts attesting to his clan-brand and manhood in the tribe, and to his duty done in mourning for lost relatives. As one listens to the chattered sounds of these creatures of the wilds and observes them feasting gluttonously upon half-cooked snakes, insects, or lily pads the thought that man is but the descendant of ape-like forms overwhelms one with a horror of conviction as we realize that our own ancestors may once have been such as these.

Only where Papuan influence is apparent does he exhibit any considerable skill in arts, and even here nearly all his implements are designed either for war or the chase. He never cultivates the soil, and lives crouching under the shelter of miserable domelike huts of bark or leaves. The boomerang is his most characteristic weapon, although the spear is actually in more universal use in Australia, and it is doubtful whether even the boomerang was invented in Australia for it is known to the

Malay Houses in the Celebes.

natives of Ceylon and Timor through which the Australians are supposed to have passed on their way from India.

There are rarely more than fifty persons in a tribe, and they live segregated from and suspicious of all others of their race. So restricted is intercourse that in Queensland alone there are more than one hundred distinct languages. Indeed everything about them points to the extreme antiquity of this primitive race whose apparent Indo-Aryan affinities appear to ally them more closely to ourselves than to the Papuans of New Guinea. There is indeed some reason for the conjecture that these hideous people of Australia came originally from Hindustan where their modern cousins are represented in the tribes of the Dravidian coast.

Women occupy a hopelessly degraded position among the Australians, being little more than slaves of their savage captors, who may wound and maltreat them in a shocking manner. Yet in all things the Australian is better where his contact with civilization has been least, for all that is corrupt among us gathers to his ruin and, after a few generations of lingering agony, he vanishes a prey to hideous disease. Far from the coast, hidden in the dense forests of tropical Queensland or in the vast wilds of the Northern Territory there are still superb specimens of this fated race, and even in higher qualities the Australian may not be wanting. One must indeed admire the courage of the lone native of the desert who with a single spear withstood the coming of the explorer Giles and his caravan of camels which must have appeared to him as demons from a supernatural realm.

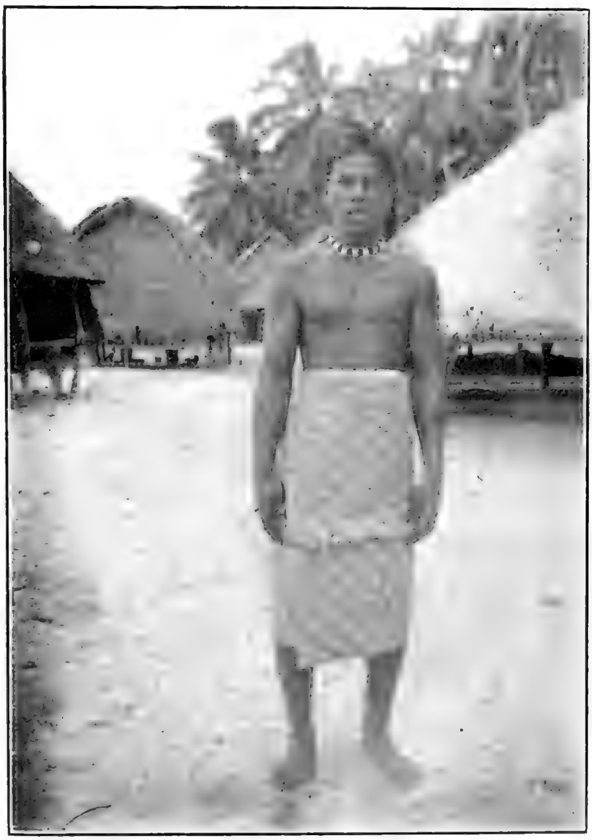
Courage, an attribute of all mankind, they have yet in common with ourselves, and as with all simple people, their deepest fears are but the figments of their own imaginations, thus in Papua and elsewhere where the chiefs have but little power, the sorcerer becomes the dreaded tyrant of the tribe. Here as elsewhere over the Pacific, the whites found the natives shuddering under the espionage of a host of evil spirits of their myths, and even to-day when Christianity has in great measure supplanted old beliefs, it is the sermon narrating the horrors of hell that commands their entranced attention. A deity of love is still to them but an unnatural abstraction and a vengeful, jealous demon, delighting in his opportunity to punish, is still the favorite god of the natives of the Pacific.

Yet primitive though the Australians are in most respects and unresponsive to the influences of higher cultures as they have always remained, the researches of Baldwin-Spencer in the Northern Territory show that the natives have been systematically under-rated by previous observers, for in their complex and picturesque ceremonial of propitiation to gods, ghosts and ancestral spirits, as well as in their rigorous etiquette and respect for fundamental rights within the tribe, they chal-

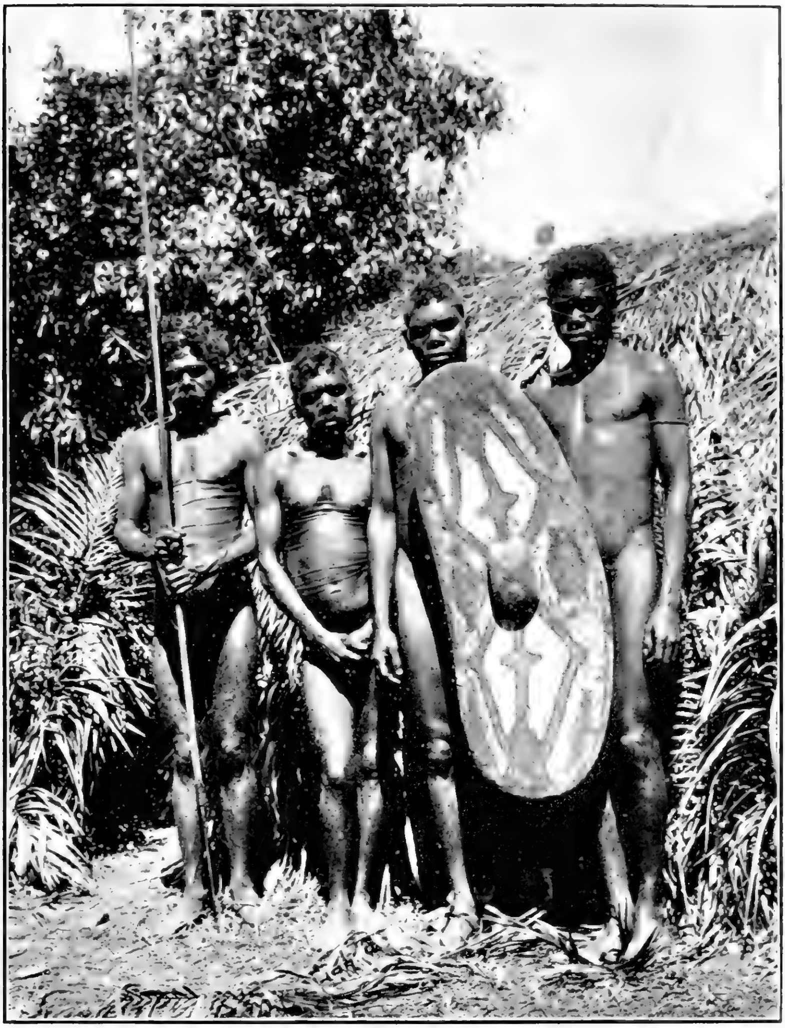
lenge high admiration. A ceremonial deep-rooted in tradition and fixed by unchangeable custom controls nearly every act, and tinctures every thought of their lives. Even in the minds of the young men this ceremonial occupies an important place, but as years go on a greater and greater proportion of time is devoted to its observance, so that religious rites and dances become practically the sole occupation of the aged.

The skill of the Australians in tracing barely discernible trails through the forest is extraordinary, for they follow at a run the track of a horse which passed over the ground five days previously. Their young children learn to read with greater rapidity than do those of the whites but advancement soon ceases, and arithmetic is a stumbling block which they rarely or never overcome. Indeed, in the wilds they are commonly unable to count beyond three or four without objective aid.

So small are the tribes, and so transient their settlements, that there is little communal organization for defense, and thus it is that in Australia the chiefs are held in but little respect, whereas among the Poly-



Man of Tari Tari Island, Gilbert Islands. A type of the Micronesian.



NATIVES OF KURANDA, QUEENSLAND, AUSTRALIA, standing in front of their house. The self-inflicted scars denote mourning for dead friends and relatives.

nesians where the village is a store-house of valued property whose owners must be both defended and aggressive, the chief gains so high an importance among conditions incident to a state of feudalism, that he becomes a semi god-like personage across whose shadow none dare pass, and who must be addressed in language more primitive and ceremonious than that used in conversing with ordinary men. A great body of tradition transmitted verbally from generation to generation has grown up in Polynesia, and the ancestry of the chiefs of the Malietoa family of Samoa is traced thus for twenty-five generations, and stories of voyages from Samoa, the Cook Islands, and Tahiti appear in the songs and myths

THE PRECIPICE NEAR KATOOMBA IN THE BLUE MOUNTAINS OF NEW SOUTH WALES.

of New Zealand and Hawaii. The question "What canoe did your ancestor come over in" is an important one in Polynesia as well as in Massachusetts. Yet in Polynesia, as with ourselves, the treasured traditions are those telling of the achievements of ancestors and the great deeds of aliens are soon forgotten. Thus, when Cook reached New Zealand in 1769 he was surprised to find that the natives retained no traditions respecting Tasman's visit to their shores in 1642.

As La Farge says it is remarkable that the development of art among

the peoples of the Pacific is by no means commensurate with the standard of their general culture. It is true that the Australians, who are probably the lowest, display no considerable skill in their arts, but the Papuans excel the more cultured peoples of Samoa and Tahiti. In the Pacific, as with all savages, art constantly manifests a symbolic and religious tendency. In Eastern New Guinea and the Trobriand Islands, the theme of the decoration is the representation of the head of the worshipped frigate bird, while in the Cook Islands the elaborately carved paddles were covered with the conventionalized figures of tribal heroes. Almost if not every design, could we discover its history, would be found to be a picture-prayer to a demon, ghost, or ancestral spirit of the tribe. Art's chief concern is to placate spirits powerful for good or evil. Yet human nature in far Polynesia is not different from its co-type in Paris, and in every savage tribe those who love form and color, love it for its own sake and, like Whistler, feel that art *is* and needs no mission to justify its being.

It is always the spirit of the man who has been murdered that the South Sea Islander dreads, and should a tree fall, all within hearing flee to avoid the sight of the disemboweled ghost of the victim of some half forgotten feast. The very breeze among the palm trees whispers tales of a horrible past.

Everywhere over the Pacific Islands, be the inhabitants of what race they may, there are certain fundamental things in which they are alike. The house is but a single room, and among the cruder tribes it serves not only as a shelter for the family, but also for the housing of pigs and chickens. Property in Polynesia is possessed by the family or the community rather than by the individual, and under certain conditions if a member of the tribe steals from his neighbor and succeeds in secreting his possession for several days he acquires a personal right to that which he covets, and may then appear acknowledged by all as its owner by right of strategy. The system of barter is usually direct without the intervention of any sort of currency, and presents in our sense are unknown in the Pacific. Your intended gift will be received as proffered barter, and returned at once if it be undesired. Thus it is that white-handled knives could not be disposed of even as "gifts" in Fiji, while black were readily accepted, and conspicuously patterned red and white waist-clothes must be presented in Tahiti, but dark blue ones are in vogue in Fiji.

Everywhere one finds traces of the customs of cannibal days revealed at times in acts the significance of which is now unthought of. Thus in Samoa the village reprobate is wrapped in leaves and carried through the town, and then placed upon the cold stones of an oven, the fire in these days remaining unlighted. In Fiji, the deepest insult is to refer to a man as the "son of a roasted father."

Among uncultured peoples the rulers aided by the priests soon invent

EUCALYPTUS TREES AND SANDSTONE PRECIPICES NEAR WENTWORTH FALLS IN THE BLUE MOUNTAINS OF NEW SOUTH WALES.

means to relegate to themselves privileges which once were shared among the many, and matters thus restricted to the few finally become shielded from the masses by religious screens which take the form of tabus. Thus over the Pacific, cannibalism which once simply satisfied the appetite, of the starving, became religious in its significance and restricted to the aristocracy, among whom it was supposed to transmit to the victor the virtues of the vanquished; to this end being practised by the North American Indian as well as by the Pacific Islander.

Man must measure all things in terms of his own experience, and to the Pacific Islander we ourselves are imagined to live in small communities upon distant islands. We are supposed to know personally all other white men and many an unfortunate mariner has been held responsible for the evil acts of those of other ships—his friends and tribesmen from the native's point of view. Thus it was that, in 1839, Williams the great missionary was murdered in the New Hebrides in revenge for outrages committed upon the natives by previous visitors, and the philanthropic Commodore Goodenough met death at Santa Cruz from a similar cause in 1875.

All sorts of miracles are expected from the white man, and it is only rarely that a native evinces any surprise at our acts. The working of great steam engines, the phonograph, photography and the electric light are taken as matters of course even though seen for the first time. I have, however, seen a Polynesian chief too greatly alarmed to wait for his beverage when upon pressing a button an electric bell jingled in the adjacent room; another leaped overboard in a paroxysm of fear when given a cake of ice, while in another instance the uncanny event of the visit was the glowing of an electric light immersed beneath the sea. Wilkes found that the Fijians were far more afraid of his rockets ("fiery spirits") than of his guns or cannon. Miracles to be received as such must fall within the field of our partial comprehension, the wholly inexplicable is neither miraculous nor interesting. A Fijian

LOOKING DOWN THE VALLEY FROM GOVETT'S LEAP IN THE BLUE MOUNTAINS OF NEW SOUTH WALES.

A Tree Fern in the Primeval Woods of Queensland.

taken to Sydney gazed stolidly upon the great buildings with no expression of surprise, but was deeply stirred upon seeing a two-wheeled push-cart laden heavily with bananas.

A custom which is probably of Polynesian origin, but has spread universally over the Pacific, is that of the tabu which was a consequence of the communistic ownership of property. The ceremony of the tabu is pronounced by the high chief, and thereafter none may molest the protected place or thing. Thus the cocoa-nut palms are made tabu while the fruit is maturing. There are, however, many forms of personal tabu which merge into witch-charms and threats of evil, for belief in witches is universal over the Pacific.

In the South Sea Islands women are considered to be the property of men and the ceremony of marriage where it exists shows its kinship with that of the tabu. Struggles for the possession of women are almost the sole cause of native warfare, and everywhere woman is the servant rather than the companion of man, although in some places her domestic

duties may be the reverse of our conception, as in Truk in the Carolines where the woman goes out upon the sea to fish, while the husband remains at home to care for house and children. The "house" is however only a combination of chicken-roost and pig pen. It is due to the looseness of the marriage tie and not to respect for women that name and rank descend through the maternal side, the mother alone being ascertainable with certainty.

A pleasing element in the life of the Polynesians is their system of entertaining strangers. The largest edifice in the village is set aside for this purpose and is called the "strangers' house," and upon the coming of guests it resounds far into the night with the sound of song and dance. When the copra is to be gathered, or the taro matures in the swamps, or the yams have grown big upon the mountain sides then one hears the songs of many a canoe bearing youthful visitors gaily decked in garlands, and singing to the rhythmic splash of paddles as they glide along the

NATIVES OF PONAPI, CAROLINE ISLANDS.

House at Eua Island, Tonga.

shore. The entertaining village is then full of merriment until the labor of the harvest is over when the chief apportions all among the families of his village and their guests. For socialism is the dominant spirit of life in Polynesia.

The chief holds property only in the name of his tribe, the individual hardly exists as a personal owner of earthly things, and intelligent natives have declaimed to me against "the money of the white man" saying that "it was the cause of all our selfishness." When I spoke of our paupers to a head chief of Fiji he asked in surprise how could this be for "surely their friends would feed them were they hungry." In Fiji years ago, so the story goes, an ambitious young native became a clerk to a grocer in Suva, and so good a salesman was he that his English master sent him back to his native village with a goodly supply of grocer's stores. Whereat old friends and neighbors came to partake of these things but were told that all were to be sold as did "the white man in Suva." In a storm of rage the contents of the budding grocer's shop were divided among all in the village, and the "meanest man in Fiji" returned to "the white man's town."

In Polynesia an era of dark portent dates from the white man's coming, for long ago they were content in the thought that the village had always been there since the sea-god Hiro had piloted their ancestral canoe to the Island from that other Island of Hawaiki far to the westward in the region of Pulotu where the dead go home in the evening. Through all the ages since those long gone days the thatched houses

had clustered under the shadows of the cocoa palms, and rustling leaves and murmuring surf had lulled the village in its sleep. As it always had been so it was, and so men felt it would endure as did the long blue line whereon the ocean met the sky. Unchanged it always would be so the old dreamer Maui sang until a canoe would come that would float upright without an outrigger; an impossibility as all men knew.

But one day it came, that God's canoe without an outrigger. Cloud-like it shaped itself and grew ever more ominous and vast until its huge sails towered above the palm trees, and it came to rest. It was the canoe of the Papalangi, they "who came from beyond the sky." Then pale-faced ghosts—"the sailing gods"—came upon the island, and the new era commenced for the little village.

A long sad era that endures to-day, darkened by the horrors of strange disease and death, humiliated by the domination of avaricious and unsympathetic masters who peonized the bodies and despised the traditions of the people of the little village so that to-day it lingers silent and withering, where once its songs of merriment were heard.

May we from our cultural heights descend to cheer with kindly sympathy these children of the Island World? Is there aught in our civilization that can serve to instil into their minds new hope, to reestablish industry, and renew ambition? The task is difficult indeed, for the weak have always been the victims of the strong, be they civilized or savage.

The very possession of skill in arts and trades has penalized the

CANOE AT VAVAU, TONGA.

natives and subjected them to the persecution of the bigoted and the avaricious.

Fair play is sadly needed—indeed the thing most needed—in the Pacific of to-day. Only through governmental action can adequate craft-schools be maintained and markets found and developed for the products of native manufacture.

It is a sad reflection upon our civilization that, through wanton neglect, the world has lost the art of the famous wood carvers of New Zealand, the mat and fan makers of the Marshall Islands, and the tapa decorators of Hawaii, Samoa, and Fiji. Yet under sympathetic guidance these crafts might have been modified to conform to the demands of world wide markets and the carved furniture of New Zealand, the artistic floor matting of the Marshall Islanders, and the attractive wall papers of the Hawaiians might have been the prized possession of many an American and European home.

Grant them but a just profit for their labor and the races that now are dying of apathy would suddenly awaken into ambitious, self-respecting men and women.

GOVERNMENTAL OBSTACLES TO INSURANCE[1]

By Chancellor DAVID STARR JORDAN
STANFORD UNIVERSITY

I HAVE been asked to speak on the topic of governmental obstacles to insurance, not that I have any special knowledge of the topic, but because these "obstacles" form part of a system of discipline with which I have had some experience and in which we may find something of interest. The obstacles in question are those of compulsory state insurance, a paternal arrangement which safeguards the worker without any will or initiative of his own or even against his purposes. The insurance premiums are not a gift, but a forced withdrawal of some portion of the workman's earnings, and the need to preserve his claim to these savings serves as a safeguard to prevent him from wantonly leaving his job. Naturally this system, with the accompanying system of old-age pensions, tends to cut the nerve of personal care for the future by throwing the responsibility on the state. Naturally, also, it interferes with the normal working of insurance arrangements, for these appeal to individual initiative and forethought. These thrive best in an atmosphere of freedom, while the systems of state insurance and old-age pensions deal with men and women mainly as cogs in the wheels of a great industrial machine.

We all recognize in theory, at least, the value of some sort of discipline. This involves an orderly use of one's powers and a willingness to subordinate our whims or our interests to some general system related to the common welfare. Discipline implies obedience, and the different types of obedience indicate the nature of this discipline. We may recognize three classes of discipline of grown men. These we may differentiate as democratic, social and paternal. Under the democratic discipline each man is responsible to himself for his own guidance. The period of preliminary education past, he chooses his profession, his own ideals, his own place in the world. Democracy means opportunity, nothing more. It opens the whole world before each man, and so much of it is his as he has the wisdom, the strength and the patience to take. This life is not successful unless he has the wit, the soberness, the virtue to make it so. If he has the chance to rise, he has also the chance to fall. He is not held in his place by dull averages. If he is able to develop no ideal, if he wastes his strength in dissipation or vice, if he is one of the unfit in the struggle for life, he must in some degree take

[1] Substance of an address before the World Insurance Congress, Panama-Pacific Exposition, San Francisco, October 8, 1915.

the consequences. Under a democracy, the government is simply the cooperation of the people for mutual aid, to achieve those needful results which are beyond the reach of private effort. Its main duty is summed up under the head of justice. And under this head come sanitation, education, the conservation of resources, the making of roads and public buildings and the maintenance in national and international relations of law and order, those conditions which permit of progress, of normal effort and happiness, which we call by the general name of peace.

What I call social discipline arises through obedience to ideals formed in cooperation. One's inspiration arises not primarily from within, but from the thoughts and needs of his neighbors. At its best, the social discipline is an outgrowth of the democratic discipline. It is through its agency that the great cooperative efforts of our race are achieved. To work for the nation is not the same thing as "to hold down a government job." The vulgar attitude towards public affairs is found in all nations—the most pronounced in those least advanced and least democratic. But a sense of social service is one of the best incentives to personal efficiency. It is this sense which has vivified the fight against yellow fever, the bubonic plague and the multitude of minute organic pests which we know by their effects as infectious disease. It is the impulse of social service which has built the Panama Canal, which is restraining the floods of China, which is healing Serbia and feeding Belgium, which in every nation in its degree is fighting against the War System, its theory and its results.

The social discipline must rest on some system of voluntary cooperation. It can not be enforced from without. Its purpose can not be accepted as a substitute for achievement. In any form of enforced cooperation, the fine spirit of social service is lost somehow in the governmental machinery. Thus far the communistic state has been successful only as a theocracy or a tyranny. And a state ruled over by a detached few is not cooperative: nor can it be democratic or just.

The paternal discipline is that applied to the people of a nation from the outside. The people are chattels of the state, having no control over its actions, the state having a glory and a prosperity wholly independent of the prosperity and happiness of its people. And by the same token, its rulers must govern by divine right, else they could have no sanction at all. There are but two sanctions for government, the one the will of the people, the other the divine right, by which the reigns of power were snatched from the people before they were born.

Under paternal discipline, the citizen has no rights save those accorded to him by his overlords of the state. The forms of democracy under paternalism are forms only useful to keep him amused while his neighbor peoples work out their experiments in liberty.

Most men in every nation are laboring-men. In democratic discipline in his degree, each man chooses his place of labor, and rises or falls

according to his own ability, fitness or training. A low estate at birth is no bar to his future exaltation. It is the essential feature of the paternal discipline that most men stay where they are put. Freedom is defined as that of cheerfulness which results from satisfaction at having any place at all in a world which is said to be overpopulated.

The son of a working man finds himself in face of a multitude of trades. He is sent perforce to a trade school, and is relieved from the menace which threatens unskilled labor. The fees are low, as is also his capacity for paying them. The differences among men are reduced to their lowest terms. He finds himself in some definite niche in the industrial machine. Government intelligence offices find his place for him. Government insurance keeps him there. He can not well fall below his class. He can not easily rise above it. For his modest future he must depend on his savings, not on promotion. The university, the professional school, are out of his reach, except in the rare event of being a born prize-winner, or the equally rare possibility of marrying rich. It is blue blood, not red, that mostly attracts heiresses, the world over. Universal compulsory education, technical as well as academic, forms part of the paternal system and this saves even the weak-minded from absolute incompetence. Three years of military service, under graduates of the barracks, break the individual will and leave a docile subject in all further discipline. In its "unescapable stimulus to patriotism," it fits its subject to obey the orders of higher authority without asking for reason why. The industrial value of such discipline is plain. The employer can count on skilled labor and labor that is well drilled and mostly free from the noxious spirit of individualism. To escape from his industrial position usually brings only discomfort and failure if nothing worse. The feeling of injustice works itself out in vague grouches and vaguer unrest, not in those positive efforts for change which threaten industrial serenity in nations which encourage private initiative.

In Prussia, it is said, a citizen has three duties, "Soldat sein; Steuer zahlen; Mund halten" (be a soldier; pay taxes; keep your mouth shut). These are simple, and they do not encourage initiative. Nothing is said about eternal vigilance which, as we know, is the price of liberty. Under this system, liberty gives place to security, and being a soldier, this security is precarious, for the business of the soldier is war.

Under universal conscription the individual loses his rights without acquiring duties. The task of the soldier is not his own nor that of society. He is held in subjection to a central power. In this discipline the people exist for the welfare of the state, the highest purpose of the nation being that of collective efficiency.

The workman has therefore the choice between the docile acceptance of a fate not wholly intolerable and revolt with certain misery. State insurance against poverty, unemployment or old age guards him against

total failure and at the same time cuts the nerve of any effort to gain such security for himself.

Price Collier observes:

> Real orderliness is born only of individual self-control. To deprive the worker of his choice of expenditure, by taking all but a pittance of it for taxation, is a dangerous deprivation of moral exercise. To be able to choose for oneself is a vitally necessary appliance in the moral gymnasium even if here and there one chooses wrong. It is a curious trend of thought of the day which proposes to cure social ills by weakening rather than by strengthening the individual. If the state is to take care of me when I am sick or old or unemployed, it must necessarily deprive me of my liberty when I am well and young and busy, and thus make my very health a kind of sickness. If you will have freedom, you will have those who are ruined by it, just as if you will have social and political servitude, you will have a stodgy unindependent populace.
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> The various forms of Labor Insurance alone in Germany cost the state over $250,000 a day. . . . No wonder that between the care of a grandmotherly state and the attentions of a subservient womankind the male population increases. . . . Nowhere has socialistic legislation been so cunningly and skilfully used for the enslavement of the people. No small part of every man's wages is paid to him in insurance; insurance for unemployment, for accident, sickness and old age. There is but faint hope of saving enough to buy one's freedom and if the slave runs away he leaves, of course, all the premiums he has paid in the hands of his master.

The difficulties which beset the common man in trying to rise from his class—to enter one of the learned professions or the sublimated caste of the army—deter all but the most gifted from ambition for advancement. Only real genius for scholarship or for money-getting can break the bonds of caste. This system minimizes the miseries of poverty while at the same time it checks initiative and independent thought in the mass of the people. To say that "it solves the problem of poverty" is to mistake veneer for reality. The body of the people under paternal discipline in any country are miserably poor, and the lot of those outside ranks of skilled labor is pitiable in the extreme. There is no solution of the problem of poverty which takes away the need of each man to try to solve it for himself.

There can be no true greatness of a state except through the greatness of the human units for whose welfare the state should exist. The whole world suffers to-day from the domination of a great state over a people which has lost the power of self-direction and which has abdicated the duty of government, abandoning them to the will of a military aristocracy, whose chief concern is anything save the welfare of the people.

The subordination of individual freedom to a prearranged efficiency naturally culminates in the organization of fluid force as military power, the extreme opposite to democracy. The individual under martial law has no opinions, no rights, no existence save as a fragment of humanity to be used by the state at its will. The soldier exists for war

and war is the failure of government in its highest functions. In the words of Havelock Ellis,

> To glorify the state is to glorify war, for there is no collective operation which can be so effectively achieved as war, and none which more conspicuously illustrates the sacrifice of the individual to the nation.

It is for this reason that militarism has been through the ages the right arm of privilege as the state church, the form of religion which ignores the individual man, has always been its left arm.

Writers of the day frequently contrast "Germany's success in solving the problem of poverty" with "the wretched condition of England's poor." It is said that "England has the most ungrateful and laziest poor to be found in any land," and these poor are said to be as unpatriotic as they are lazy. They are blind, too, for the pauper vote of England is almost solidly opposed to the efforts of those who would use public action in betterment of their condition.

From this it is argued that as England is a land of freedom while Germany is a land of efficiency, the ideals of freedom need reconsideration in the direction of paternal discipline.

Miss Prestonia Mann Martin observes:

> The two forms of government are to-day on trial. The watchword of democracy is freedom. The watchword of paternalism is duty. Followed to their conclusions, one leads to anarchy, the other to its opposite, socialism. One tends to decentralize government, the other to centralize it. One aims at individual independence, the other at national efficiency. One places the highest value upon freedom, the other sacrifices freedom for the sake of order, system, power, security.

This analysis is true, so far as it goes, but the end of democracy is not freedom, nor yet opportunity, the two meaning much the same thing. The ideal is also duty, but duty self-imposed, or arising from a feeling of the needs of society, not duty imposed from without.

The need of Great Britain as I see it is not more governmental system. The "sodden misery of the London slums, the horrors of the black country," the exhaustion of the countryside, the failure of the yeomanry, these call for more freedom, not for paternalism. "The inevitable toll of corruption and incompetence" is not a result of freedom. Its historic roots lie in the struggle for imperialism. They can never be absent under any form of government, so long as men are greedy or incompetent. The predatory rich and the desultory poor occur under all forms of government, and in some fashion or other the one will feed on the other and both are parasitic on the common weal.

The men who stand for more freedom in England are the men most eager to do away with needless misery and sorrow. The evils in British society are not results of democracy, but legacies of the era of aristocracy,

paternalism and imperialism. British polity still rests on inequality before the law. The statute of primogeniture thrusts the hated principle of precedence into every family. The state church discriminates against personal religion. The governmental effort not long ago to strengthen the landed aristocracy gave to England and Scotland their insoluble land problems. Only in very recent years has the free school found place in Great Britain. The holding of India at the public cost for private exploitation has enriched a very few at the expense of the very many. The wars in India and Africa exhausted in large degree the British yeomanry, while those whom war could not use slid down the line of least resistance into the slums of the great cities. There they have bred generations of like incompetents in an atmosphere of drink and vice. The young men of parts have been used and used up by the thousand in the colonial service. The weaker elements have multiplied while fine strains have been destroyed.

The liquor interests have filled Great Britain and Ireland with race poisons, and these in aristocratic times waxed so powerful that the democracy has as yet failed to dislodge them. In brief, the ills, political and social, of Great Britain have nowhere their origin in democracy, but in governmental abuses and inequalities against which British democracy, one of the strongest and most devoted of all world forces, is manfully struggling. And the most disastrous of all elements of evil, the war system, is wholly undemocratic. It has been brought on, not because democracies are "loosely organized, careless and disorderly," but because "compact brotherhoods which have been welded into a family-nation by the fostering care and the strict discipline of a paternalistic government" have become politically so incompetent that they are driven like sheep into a war which they did not want, which could bring them nothing but ruin and which in its inception and consummation constitutes in itself the most heinous crime ever perpetrated in the history of Christendom. And all this at the dictation of a very few men whom even yet the nation has failed to identify. When the whole story is told, the lesson we must read is that the remedy for the shortcomings of freedom is more freedom, that personal initiative counts more, even in national enterprise, than any form of enforced efficiency, that the need of free states is not less freedom, but more justice, for justice sets men free, and that the worst possible test of a nation's greatness is found in the mischief she can do to her neighbors in blind leading of the blind to the field of battle. That battlefields still exist is due to the failure of justice and therefore of individual freedom.

It is true, as has been stated, that

> State socialism as Germany is demonstrating demands the price and then delivers the goods.

But what terrible goods this system stands ready to deliver!

The democratic discipline, self-imposed by men who think and act for themselves, is effective in making men, and it is the initiative of individual men which makes and marks history.

The social discipline which springs from individualism is effective in building up human society, and the inspiration which rises from the thought of cooperative help is the best antidote for the greed of unchecked and perverted individualism.

The paternal discipline provides in its degree for material comfort and security. It takes away the necessary incentive to every man to solve his own problems. In a free state, the sober and honest working man should be free to abolish his own poverty, to enhance his own security or that of his family through insurance—or at his own discretion to let it alone.

DEFENDING AMERICA

By WM. J. ROE

NEWBURGH, N. Y.

THE problem of discovering or inventing a method of preparation against aggression which shall be acceptable to the entire American people is now presenting itself for solution with an insistence never before so strong or determined. Until in August a year ago the war-cloud broke over Europe, with the solitary exceptions of those versed in the swiftly increasing powers for defence and offence of the continental nations, or aware of the continually strained racial relations, the average well-meaning citizen of the United States seemed fairly confident that something very like a millennial dawn had come. Good people, respectable, well educated, church members, in their way patriotic, but a little over a year ago were saying to each other and sometimes in print to other citizens, that the world had progressed too far along the broad highway of progress for anything like a great war again to disturb the repose of the nations. The recent records of South Africa and our own war with Spain these excellent people dismissed as mere incidents of a universal slowing down of humanity's depraved instincts, or rather perhaps as "growing pains" of the angel of peace.

With all their education (for almost invariably these excellent theorists and impractical interpreters of principles which passed with them as "religious," were "educated") the philosophy of history and the rudimentary elements of psychology had taught nothing concerning the realities of the past or the prospects of immediate present or remote future. One would think that with the great European war a full year upon its course, with no end as yet in view upon the most optimistic horizon, these genial optimists would somehow or in some degree have revised their estimates of probability, or at least have devoted some serious attention to those dilemmas of our past which when understood so completely refute the arguments of "peace at any price" idealists.

Unfortunately the hideous spectacle of the European conflict, instead of having turned the attention of the ultra-pacifists to the untenability of their amiable sophistries, seems to have greatly increased their ardor in the cause of pacification, and immeasurably to have intensified the clamor of ignorant opinion as to the method of insuring peace.

Believing (with the astronomer) that it is only by determining points upon the orbit of the past that man is able to forecast at all the

trajectory of the future, the sane peace lover calls attention to the incidents of our war for independence. "Why!" the peace-at-any-price person responds, and sometimes with no little display of spirit, "Why, my dear sir, that was a righteous struggle; the people rose like one man, and drove the tyrant from these shores." It is in vain that you point to the fallacy of this harangue. It would of course be the rankest of heresies to claim—in spite of the lengthy list of iniquities in the preamble to our declaration—that George III. was not so much of a tyrant, after all, and that the war of liberation from British sovereignty was fought "on a preamble." But this is true, nevertheless; the thirteen colonies sought freedom because they were tired of being "bossed." They found pretexts for revolution in Patrick Henry's "Give me liberty or give me death," and in that excellent and serviceable aphorism; "Taxation without representation is tyranny." The people of the colonies won their freedom, and used it to their hearts' content to establish states, which ever since have taxed unrepresented—or inadequately represented—sections, with hardly a murmur, certainly without a hint of revolution.

But this is not the only—nor the worse—fallacy. The people rose like one man, did they? Most assuredly this was not all that happened. They rose indeed, everywhere along the seaboard from the province of Maine to the far South; but it was like a mob they rose, untrained, insubordinate, in general fair marksmen, but for squirrels rather than men, splendid material for armies, but so ill disciplined—at least till Washington took them in hand at Cambridge—that their assemblages were more like training-day musters than the van of war. Great man as he was even Washington could hardly have succeeded in molding mobs into soldiers if his efforts had not been finely aided by those gallant Germans, Steuben, Pulaski and Du Kalb. Indeed the philosophical analysis of conditions resulting in final success of American arms at Yorktown discloses most certainly that independence was due to three prominent factors: the gallantry and "war-sense" of Benedict Arnold at Saratoga, bringing about Burgoyne's surrender, and thereby the French alliance. Without that and the cordial aid of La Fayette, De Fleury, Rochambeau and others of that military nation, Cornwallis would doubtless have dealt with our forces on the York as easily and cleverly as he outflanked and outmanoeuvred Washington at the Brandywine.

And the war—so called—of 1812, what a wretched account of themselves our hastily gathered land forces gave; with the single "saving grace" of New Orleans, fought after the war had ended, the records include merely a discreditable series of defeats, routs, retreats and surrenders. Only the audacity and skill of an ill-prepared, manned and munitioned navy saved the country from total and irremediable dis-

aster. But fortunately the navy was audacious and skillful; it fought everywhere "to a finish," gave us a very real standing upon the high seas, and as a priceless heritage the illustrious names of Decatur and Lawrence and Porter and Perry and MacDonough, and their many hardly less worthy subordinates.

In Mexico, for the first time in our history (apart from the services of the few graduates of West Point, mainly utilized in the construction of fortifications in 1812–14) the country had the benefit of a large number of officers trained at the Military Academy in the science and art of warfare. Under the able leadership of Scott, Wool, Worth, and Harney these young "graduated cadets" so efficiently led the few thousands, mostly volunteers, against a nation in arms, that peace was achieved in a few months, which otherwise might have required many years.

To recount the incidents of the opening of our great Civil War, or even to touch upon them with a too truthful pencil, would, it may not be doubted, in any other country in the world, be to awaken memories that had better be left to slumber and oblivion. But to Americans of to-day the horror and the gloom of half a century ago have passed forever; to us—South and North—the years when the land was "drenched in fraternal blood" are no more than the wars of Marius and Sylla, or the roses—white and red—of the rival lines of Plantagenet.

The peril of "states dissevered, discordant, belligerent," was averted by force of arms. Arguments failed, or intensified the rancor; diplomacy was unheeded, compromise scornfully rejected; there remained only force, the first appeal of passion met by the last resort of patriotism. Force succeeded, but at what a frightful cost! hundreds of thousands of lives, billions of money. It can not be said that surely all these expenditures might have been saved if in the year 1861 we had had a force of fifty thousand men in arms. But though such a force, guided by one calm cool head at Washington, might not have averted the conflict, the strong probabilities are that at least they would have served to give time for passions to subside, and for reason to resume her rightful sway.

The almost total unpreparedness of our scant land forces at the outbreak of the Spanish war had the effect—temporarily at least—to call the attention of the nation to our deficiencies. For a time the glaring maladministration of military affairs of the department at Washington was a public scandal; that we won, and so quickly, was due largely of course to the very great efficiency of the small navy, but far more that the Spaniard, though passionate as he was valorous, was yet no fool; he recognized and accepted the inevitable, even though his forces in Cuba overmatched our own in numbers nearly sixfold.

Since the peace of Paris our military affairs have been placed upon

a basis far exceeding anything previously known to ensure efficiency, especially by the establishment of the General Staff, replacing former lax administration by a supervising authority, coordinating all branches of the service under a single responsible direction. Unhappily for the strength of our armament for defense on land, while there has been no increase of forces authorized by Congress, the necessity for an increase has come from the very considerable territorial expansion consequent upon the acquisition of the Philippines, Porto Rico, the Canal Zone, and the islands of the Pacific. Adequately to police these new possessions—saying nothing of their defense against possible foreign aggression—would require an army very much larger than that now established by law.

The American people as a whole are very easily scared (that is, startled), but very difficult to frighten (that is, to disturb by fear). To say this is in a way complimentary more to the value of our emotions than to our reason, for certainly the courage of the naturally timid and "nervous" is more commendable than the stolid bravery that merely lacks imagination. But it is unfortunate, for, as all of our emotions are designed for utility and not brutality, fright has its use in way of warning, distinctly notifying the frightened to take steps to avert the threatened danger. But Japan signified unmistakably her vexation, and Mexico her contempt, without arousing the American people to a consciousness of either possible peril or certain responsibility. We disregarded Japan's grievance as of no real importance, and as for the Mexicans, knowing that from them was no danger of invasion, we have given absolutely no thought to what the future may disclose concerning our obligations as trustee according to the Monroe Doctrine to foreign powers.

From this condition—a mingling of bravado, apathy and indifference—the great war in Europe has thoroughly aroused the American nation. All over the United States, from politicians, editors, essayists, "militarists," and "peace-at-any-price" people, come addresses, pamphlets, articles, serials professing to forecast perils from foreign invasion, while societies are being organized, some to stimulate interest in military affairs, and some to discourage such interest, even to the extent of endeavoring to affix a stigma upon the soldier by ostracism and unpatriotic ditties denouncing him as a murderer.

And this discordance is further complicated by varying opinions concerning the respective merits of the causes now rending the continent of Europe, opinions for the most part expressed guardedly and with at least some consideration for others, but fixed in racial sympathies.

At best the position of a neutral nation in any war of considerable magnitude is liable to become perilous, especially to a nation having an

extensive foreign commerce. We know what occurred over a century ago when Europe was overrun by the armies of Napoleon—that international compacts were disregarded, the rights of neutrals ignored, and our own merchant marine threatened with annihilation by paper edicts. A similar process has already been begun across the Atlantic; already we have had thrust upon us a "Berlin decree" from Germany, and "Orders in council" from Great Britain. Doubtless the offense of Germany against the law of nations has been by far the most flagrant; but Great Britain—by interfering with the trade of one neutral nation with another—has exhibited a disregard of that law in relation to our trade with countries bordering upon Germany, which (notwithstanding our own precedents) has caused strenuous remonstrance. That both nations—with great civility and with deference to our colossal growth since 1800—set up as a plea in bar of action a necessity justifying—or condoning—action, merely adds to the difficulties which already confront America, and which are certain to continue and increase as trouble-making incidents.

As never before in our history we are surrounded by conditions and latent grievances liable at almost any moment to take on the shape of antagonisms. In venturing to point out—one by one—the chances of the future, it is not to invite unfriendly feeling towards our neighboring nations, but solely that with calm dispassion we may view the facts, having always in mind that great certainty, that adequate preparation to repel an invader is better than enormous armaments to expel him.

With Japan we need not, I think, concern ourselves unduly. This is not to minimize the danger of a disruption of friendly relations owing to further inimical legislation by states of the Pacific coast or to a possible attempt at colonization of lands theoretically under our protection; but mainly that the Japanese are too poor and at the same time too clever seriously to incite our hostility. Poverty alone will never deter a high-spirited nation from seeking reprisals for real or fancied wrongs, and cleverness alone is apt to lead (as in the case of the German Kaiser) to over confidence in cleverness; but the two combined are fairly good safeguards against aggression.

But it is not against the probable so much as the possible that America ought to be prepared. In the present state of our defenses on both land and sea, war with Japan would mean the immediate loss of our Asiatic, and probably of our Pacific, possessions; the Philippines, with Samoa, Guam, and almost certainly the Hawaiian islands, would—temporarily at least—be lost to us. That they would not stay lost may be reckoned upon, and this is known to the keen intellect of the Japanese, perhaps even more thoroughly than to ourselves.

But why should America depend upon the forbearance of an alien—

however induced—for our first line of defense? Especially is this undesirable when already we possess outlying salients susceptible of being so fortified as virtually to insure us against invasion of our continental territory. Already we are fortifying Pearl Harbor in Hawaii, and it needs only similar fortifications of one of the Aleutian islands, with Guam and Samoa in the far southeast, with perhaps by treaty another base at the Galapagos, to establish bases for swift offense against the supplies of an Asiatic enemy and for protection of the Panama Canal. So protected by outlying fortresses having defensive relations, we should be virtually invulnerable from an Asiatic assault. As compared with the probable loot of an invader on the western coast the expense of constructing and maintaining such defenses would be inconsiderable.

Curious as it may seem, while invasion by a Mexican army is something to be contemplated with complacence, the danger which may arise from that quarter is far more menacing. At the present moment of course the powers of western Europe have enough to do without seeking trouble in America. But suppose there had been no war to engage the attention of either Great Britain or Germany; is it likely that either country would have permitted the spoliation and murder of its citizens to go on as it has for several years, life and property at the mercy of one or the other of a number of irresponsible bandits? Certainly that could not have been expected. With courteous diplomacy no doubt, due deference being accorded to our Monroe doctrine, a demand in no uncertain terms would have come long before this; we should have been required either to "fish or cut bait"; either to act the part our doctrine clearly calls for of collecting agent, or to let the creditor do his own collecting unvexed.

At the present time of writing signs are not lacking that the extraordinary patience heretofore held to by the administration at Washington is on the verge of exhaustion. An endeavor has been made to secure the moral support of the stable South American countries in an appeal to the contending factions. Even yet it seems doubtful whether the only sort of action that can possibly be effective is contemplated; more likely the policy of pottering procrastination will continue. The ultra peace lovers and optimists will tell you that there is no need of haste, assuring you that the close of the European war will find the nations so battered, so weary of strife, and so exhausted financially as to be unwilling or unable to turn their attention to the redress of wrongs suffered by their citizens in Mexico. Such imaginings are wholly erroneous; as never before will the armies of the victors in that great struggle be in shape for further conquests, while the very fact of poverty will be merely an incentive to the replenishment of an exhausted treasury. When that day comes America will surely have to choose between war and humiliation.

These being the inevitable prospects of the future for the American people, certainly it becomes the duty of every thinking citizen to do his part, however insignificant, towards calling attention to the perils, not needlessly to alarm, but soberly, calmly, judiciously, not only to seek a permanent peace, but by far-sighted preparation for a war of strictest defense, to ensure it.

Situated as America is, having an isolated continent virtually to itself, the problem of defense assumes a shape vastly different from that of one of the continental European nations, surrounded by countries whose endemic jealousy is liable at any moment to become virulently epidemic. To a very large number of Americans, probably the great majority, the sudden and violent action of Germany last year seems cruelly and needlessly aggressive. This paper is not written to assail or to defend those actions, but it may be well, while criticizing, if you please, the violation of international law involved in the invasion of Belgium, to put yourself in Germany's place, realizing, if that be possible, her dilemma, believing (as was certainly the case) that hostile Europe lay crouching ready to spring upon her. We know what happened; Germany endeavored to forestall the attack by attacking first and fiercely.

Assuming (though the assumption may be very far from correctly taken) the necessity imposed by an unavoidable antagonism, Germany's action was not only logical, but was called for by the genius of the art of war. The method of that genius has been stated—having been quite erroneously credited to a distinguished Confederate—as "getting there fustest with the mostest men."

A century ago the Atlantic ocean served as a very efficient rampart for resistance against an offensive movement; to-day, when an army could easily be transported to our coast within a month its merit as a first line of defense depends almost solely upon the floating force at our command. In no event probably could any naval armament at our service wholly eliminate all danger of invasion; but to reduce this peril to a minimum, and to some extent to direct the course and point of attack, a very considerable addition to our present navy is not only desirable, but imperative. We need more battleships of the first class, we need swift cruisers, and lesser craft, for offence and for supply, and perhaps more than all, many—little and big—submarines. With an adequate force of all these, and (for both sea and land service) a host of all classes of aircraft, it may safely be said that the best has been done to avert the calamity of an assault from the high seas of an invader.

In one respect America is singularly exposed; the vast preponderance of wealth lies directly upon our Atlantic frontier; Boston, New York, Philadelphia, Baltimore and Washington are all either directly on the seaboard, or within easy striking distance of some point of disembarkation of an enemy. It is not difficult to forecast an invader's inten-

tion—to concentrate his force, for purposes of loot or ransom, against these rich nuclei of treasure.

As on a preceding page I have pointed out the propriety of fortifying various islands of the Pacific ocean as the simplest and least expensive method of defense against an armed attack from the far East, so—for the best defense of our seaboard metropolitan cities—I wish most emphatically to call renewed attention to the project (so long and so ably urged by the "Atlantic Deeper Waterways Association") of constructing ship canals capable of passing the heaviest battleships, between existing navigable channels "from Boston to Beaufort" and beyond. Especially should there be deep waterways from Boston—inland—to Narragansett Bay; thence back of Point Judith to connect with Long Island Sound (defended by a powerful work to be constructed on Block Island); again via the Kill-van-Kull and across the state of New Jersey, to the Delaware, and, more important still, across the Maryland-Delaware peninsula to deep water in the Chesapeake bay.

The great fortification planned and now in process of construction opposite Cape Henry at the entrance to the Chesapeake will eventually tend to safeguard that extensive inland sea and the cities of Baltimore and Washington. With an artificial channel adequately defended from the upper Chesapeake to the Delaware, the extreme danger of an enemy's establishing a base somewhere on the Chesapeake (most available of all locations) could probably be prevented.

The general purpose and necessary brevity of this paper precludes anything like a detailed statement of the present inadequacies in way of land defenses of our cities and harbors. On the supposition that our seagoing defenders have been baffled in their endeavor to prevent an enemy from landing upon our coast, and establishing there his base, from which he proposes to advance, it may be well in as few words as possible to outline the composition of our land force upon which—and now upon which alone—we must rely, either to drive the enemy back whence he came or at least to prevent the destruction or spoliation of our great cities.

The personnel of the land defense divides naturally into these general classes: the stationary defenders (consisting at present of 170 companies of an authorized strength of 104 men each) who man the seacoast batteries, the "mobile army," the "supply," and the "transportation."

The bulk of a "mobile army" consists of infantry, that is of bodies of men, divided into companies, battalions, regiments, brigades, divisions, and army corps, who rely—as final resort—upon their own legs to carry them into action; of field artillery, armed with large-caliber, long-range guns, smaller "mountain guns," with "machine guns" the latter usually attached to the infantry, but which may be drawn as the others are by horses or mules, together with their attendant "limbers" and "caissons" carrying the immediate supplies of ammunition. Besides these arms is

the cavalry, differing but slightly in training and arms except that they are mounted, Whose purpose is ordinarily scouting in small detached bodies, or—should such action become desirable—for raids on a large scale, or even, in some contingency quite remote in modern warfare, for a charge *en masse.*

In addition to these three branches of the service of an active army—infantry, cavalry and field artillery, a number of auxiliary troops are required to make up a complete and efficient fighting force. The engineers make and repair roads and bridges, construct earthworks and lay pontoon bridges when required; the signal corps, the aviators, the medical department, and the quartermaster corps, having in charge all matters pertaining to the feeding, tenting, paying, transporting, and clothing of the troops. There are also other staff departments, consisting of officers only, who are charged with details of administration.

While the questions of supply and transportation of a mobile army fall naturally and mainly upon the quartermaster and his assistant officers and the men of their command, many other considerations enter into the carrying out of the various problems as they arise. Not the least of the perils which might arise from invasion is that almost all the sources of arms and munitions in this country are located not very far from the Atlantic coast, and so within striking distance of an invader. Upon our Ordnance Department rests the responsibility of making and supplying guns, cannon, machine-guns, and small-arms, as well as ammunition—explosives and projectiles of all kinds. The arsenals and armories under the control of the War Department are even now, and would be of course to a greater extent in time of actual war, supplemented by the output of private concerns.

Thus theoretically may be described the essential elements of America's defense against a possible future assault by an enemy having a measurable command of the high seas sufficient to convoy in safety adequate armed forces in strength and numbers really threatening. For the purpose of repelling such an invasion, not only should all of our seacoast forts be manned and officered by a largely increased number of technically trained artillerists, but the fortifications—especially those guarding the approaches to the great cities—should be vastly strengthened—single forts and batteries united in a continuous line of defensive relations, in effect converting scattered groups of isolated works into one scientifically planned fortress. Doubtless at the first sign of real threatening word from Washington, flashing over the wires, would send local commanders to the task of further fortifying in earnest. But the conviction can not be escaped that such hasty preparation would come too late.

As for that "mobile army" which has been briefly described, in general terms this should be distributed perhaps into say three or four grand divisions; one somewhere in the far-south, located so as best to defend

the Texan frontier and the Gulf ports; one somewhere not far from Washington; another probably near Trenton, N. J., and still another at some point in New England about equidistant between Boston and New York. Each section of the active army should be composed of every element, should have at easy command both material and personnel for replenishment of inevitable losses, and each should be so located that by railway and highway and perhaps waterway lines prompt and decisive access to the enemy's landing place might be effected; be ready in short not to await the initiative, but to take it.

To write in this lofty way of fortresses and armies, and of taking initiatives with a view to driving an enemy promptly from our territory, must, I am well aware, appear quite ludicrous to military men. With a force of coast artillery wholly inadequate already, and a "mobile" force so tiny as to be utterly meaningless, to speak of defense, much less of victory, seems like very real mockery. To-day (I have no hesitation in saying) if any one single European power of the first class sought war with the United States, and was left unimpeded by any other great power, this country, in spite of its wealth, its numbers, its patriotism, would be hopelessly helpless.

The saying has been credited, I know not how truly, to a very honest, very religious, but very misguided politician, that in the event of a foreign power seeking to subjugate us, a million armed men would spring up over night to defend our beloved country, and to drive the foe from our shores. Such "spread-eagle" declamation may sound well in a Fourth-of-July speech, but practically it signifies worse than nothing. You may remember that when Julius Cæsar had crossed the Rubicon, and was advancing upon Rome his rival Pompey said to the populace: "Give yourselves no concern, Quirites, Rome is quite safe; all I have to do is to stamp my foot and many legions will arise to meet and vanquish Cæsar."

Most of the Roman citizens were well enough satisfied with this; they said to one another that Pompey was a great man, at least that he was a lover of peace, and had a fine gift for phrase-making. But before long news came that Cæsar had taken Corfinium and captured the army of Domitius. So the citizens came again—this time in a hurry—to Pompey's house, to say: "You promised to provide legions to defend us from Cæsar by stamping your foot; we merely wish to say that the time has come to stamp." Pompey was very polite to his callers, and replied that he would see that something was done; but nothing was, and when next we hear of Pompey it was as a fugitive from Pharsalia.

The analogy of the above anecdote is defective in several particulars; our people are by no means as ignorant or as apathetic as the Romans were, and certainly few of them have any sort of confidence that a defending army can be raised over night. In fact it is not the lack of stamping that is the trouble (for everybody seems busily engaged at

that), but that no one appears to have stamped for exactly the right thing, or at least not in exactly the right way. Some—the so-called ultra "militarists"—are demanding an immediate and huge standing army; some—the extreme "pacifists"—claim that a policy of complete non-resistance is the one most likely to be effectual. These good people quote the saying of the Master moralist of all time, as to his duty who is smitten upon the one cheek to turn the other also, forgetting that it was said as strenuously and by the same authority: "How can one enter into a strong man's house and spoil his goods except he first bind the strong man!"

And between the extremes of "militarism" and "peace-at-any-price" how many varieties of urgent opinion are voicing their views! Some advocate compulsory teaching of tactics in the schools, some have great hopes from "boy scouts," some, scandalized at the idea of any increase in the regular army—as likely to "imperil our liberties"—would be glad to see the militia of the several states amplified to almost any extent, and some, good citizens, having the welfare of the country at heart, establish drill organizations, learning something while having an enjoyable outing. Not one of all these notions and experiments but has in it elements of value, and no one would seek to disparage them; but in fact, in the event of a real war suddenly thrust upon us, all of these put together, including even those "continentals" now recommended to Congress, would hardly prove a feather's weight towards that dynamic force which alone could suffice for defense. Probably the method and purpose of the organizations known as "The American Legion" and the "National Security League" whose headquarters are in New York City, are more likely to prove efficient as an auxiliary to a national army rightly recruited, organized, and officered, than all other adjuncts or volunteer aids combined.

The question of establishing an armed land force sufficiently numerous to repel any invasion at all likely to threaten the country must be considered from two different standpoints; first, as to what may be done by Congress under the constitution and the laws, and, second, what is feasible in view of the traditions of the American people and their evident distrust of any considerable "standing army."

The constitution gives to congress the right to raise and support, govern and regulate an army, of which the president shall be commander-in-chief. Inasmuch as no limitation is placed upon the size of the army, manifestly it is within the legal powers of Congress to call every able-bodied citizen to serve as a soldier—to adopt if it sees fit the absolute militaristic system common to the countries of continental Europe, a system which finds perhaps its best illustration of combined efficiency and expediency in the military administration of the Swiss republic.

Included also among the powers expressly delegated to Congress is that which gives the right of "organizing, arming, and disciplining the

militia" and for employing these state forces in the service of the nation. The sole restriction upon federal authority over state troops when called into active service is that to the states is reserved the right to designate the officers and to do their own training subject to congressionally prescribed methods of discipline.[1]

Manifestly it would be quite impracticable to introduce the Swiss system in its entirety into this country. The people would not submit to so radical an alternative, and again such a huge force, even if it could be officered, supplied or transported, would be too cumbersome and unwieldy for anything like efficiency. Our total present force consists of about 90,000 regular troops, and something over 100,000 militia all told, in all subject to the call of Congress and the President to-day, almost exactly 200,000 men under arms. Between this force and a "levy en masse" the golden mean of availability must therefore be found. That "volunteering" can be seriously relied upon to furnish a competent army of defense must be dismissed as untenable, if only because of the time required to convert an "armed mob" however patriotic, into veteran troops.

Having in view all the circumstances, conditions, resources and prospects—most of which have been at least touched upon, however lightly in this paper, it will be for the president to recommend and for Congress to enact such measures as shall most surely guarantee to America that assurance of safety from aggression which just dealing and diplomacy may go far towards effecting, but which an armed force of suitable strength, well armed and munitioned, and ably led alone can insure.

The virtually unanimous opinion of military men, founded upon the known results of practical experience of foreign countries and with our own army, and modified by an intelligent understanding of democratic needs and prejudices, is convincing that Congress should provide forthwith somewhat as follows:

I. For a very considerable increase of the *coast artillery*, the total, officers and men, to aggregate nearly if not quite 50,000.

II. Providing for an increase of the present *mobile force*—infantry and cavalry—the total to be not less than 150,000 and perhaps need not be more than 200,000. The grand total of the regular army to be from 200,000 to 250,000, preferably the larger aggregate.

III. Providing for an enlistment period which may be approximately eight years, of which two or three shall be *with the colors*—that is in active service, the balance of the enlistment period to be with the *reserve*, subject however always to rejoining the colors. These reserves to be adequately paid, but unrestricted as to occupation.

IV. Providing for prompt *expansion* of the active army in case of

[1] See Constitution, Article No. I., §§ 11, 12, 13, 14, 15, and 16, and Article No. II., Section 2, § 1; also Amendment No. II.

necessity, not by creating new organizations (of reserves or volunteer recruits), but by incorporating the reserves immediately, and the volunteers when sufficiently trained, with existing units of service.

V. Providing for an increase in number of *officers;* this to be by adding to the number of cadets at the Military Academy, and by commissioning such graduates of colleges and universities with the higher class of private schools, as may be proficient in an established military course directly under authority of the War Department.

VI. Providing for the accumulation of stores of *war-material* of every kind at depots to be established at inland points, easily accessible by ourselves for distribution, and easily defensible from an enemy.

VII. Providing for strict regulations by which the militia of the several states may more readily and efficiently become incorporated with the regular forces in time of emergency. It is also suggested and urged that state constabularies relieve the militia from ordinary police duties.

The details of method for the carrying out of these and other only less essential provisions should be left largely to a board to consist of chairmen of committees of the House and Senate most directly interested, the secretaries of war and the navy, and those officers of high rank in both services whose position and experience qualify them to suggest or decide between expedients.

While undoubtedly the considerable increase of the army as above outlined would add largely to the expense, several methods of economy may be suggested. That provision concerning length of service as applied to the land forces in general might be materially modified by the establishment of more permanent garrisons "beyond seas"; and a large saving in the item of transportation could be effected by local recruiting. Heretofore, owing to the demands of political expediency numerous small posts, which have long outlived their usefulness, have continued to be garrisoned, entailing in the aggregate a large drain upon funds and men, for both of which better use could be found at stations more suitable, especially for the practise of regimental and brigade evolutions.

Within recent years the quality of men accepted by recruiting officers has very greatly improved; it is suggested that the localizing method of enlistment and the feature of the reserve might still further assist to increase the character, stability and permanency of the men-in-the-ranks. It would be a wise measure to afford to young enlisted men very greatly increased opportunities to attain commissioned rank, and if inclination led and natural ability permitted, that many such should find the way open to making their country's defending a life career. For the so-called "scientific corps"—the engineers, the ordnance, and the artillery—long and arduous training is required; but for the line—foot and horse troops two years or so of due diligence is sufficient. Here the extremely high standard of education at West Point could well be modified. Moral character, physical stamina, a fair general education, with natural capac-

ity for command and willingness to obey; these furnish an ample foundation for the sort of training qualifying for commissioned rank in the line. For advancement to higher grades in the service the experience of the war-between-the-states testifies that time may be trusted to provide its sure tests of merit quite irrespective of that detriment to efficiency—the handicap of seniority as determining promotion.

To make provision for establishing "peace on earth and good will" between nation and nation is no more vital to-day than it has been since first the interests and passions of men began to call for enlightened self-control. And to provide for defense against a world mad with murder, abandoning its own mutual guarantees of civilization is now hardly more essential than it has been for many decades. But the recent shameless spectacle of reversion to barbarism exhibited to-day in Europe and on the high seas has aroused attention to our weakness as never before. It is no fit reply to those who announce the necessity of adequate preparation to cry that war is barbaric. It is barbaric; but so long as barbarians remain upon the earth, it will be the duty of enlightenment to provide safeguards against them.

THE YOUNGER GENERATION OF AMERICAN GENIUS

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1. The Group Under Forty-five

A STUDY[1] of the first ten thousand American-born persons whose names appeared in "Who's Who in America" for 1912–13 showed beyond any reasonable question that up to that time New England had made a contribution of eminent Americans far out of proportion to her population. This fact held true for New England as a whole. Furthermore, the number of distinguished persons per one hundred thousand of population was larger in every New England state than in any other state in the union. So decisive was the advantage of New England that Rhode Island, the New England state with the lowest proportion of distinguished persons per one hundred thousand of population, was 30 per cent. above New York, the state which, outside of New England, had the highest proportion of distinguished persons per one hundred thousand of population.

The ten thousand persons considered in this first study were for the most part well along in life. Only one in a hundred was born since 1880; only fourteen in a hundred were born since 1870. More than a quarter of the eminent persons were born before 1850, making them at least sixty-two years old.

The tables showed, clearly enough, that the advantage of New England over other sections of the country decreased in later decades. Among the eminent persons born before 1850, 30 per cent. were born in New England, which in 1850 reported but 11.8 per cent. of the total population of the United States; whereas for the decade 1880–89 the proportion of eminent persons born in New England was 12 per cent., as compared with 7.5 per cent. of the population reported from that section.

Certain critics insisted:

> That proves the point, the position of New England as the mother of American genius is on the wane. Make a study of the group born since 1870, the people who are under forty-five, and you will see the difference.

This is the study.

During the first three quarters of the nineteenth century, a number of distinguished men out of all proportion to her population was born

[1] "The Geographical Distribution of American Genius," Scott Nearing, *The Popular Science Monthly*, August, 1914.

in New England. Next to New England, the Middle Atlantic and the East North Central states had a considerable lead over the remainder of the country. Was this lead of the northeast section of the United States due to some special advantage that inhered in the race-stock, the climate, the educational facilities, or some like features; or to the mere momentum of tradition and established prestige? Such a question can not be answered categorically, but an analysis of the younger group of distinguished Americans will show whether the tendencies noted in the previous study are so evidently casting laurel wreaths at the feet of New England.

2. The Place of Birth

New England can not claim the same overshadowing position in the production of genius in the younger generation that so clearly belonged to her in the earlier decades. While her position is still good, it is far from commanding.

The figures[2] have been compiled first according to geographical area. The 2,000 distinguished persons are distributed over nine groups of states. The largest number come from the Middle Atlantic states; the smallest from the Mountain states.

TABLE I

Number and Per Cent. of Eminent Persons born in the Various Geographic Divisions of the United States, with the per cent. of the Total Population of the United States in Each Division in 1880

Geographical Area	Distinguished Persons		Per Cent. of the Total Population in 1880
	Number	Per Cent.	
New England	331	16.6	8.1
Middle Atlantic States	503	25.1	20.9
East North Central States	480	24.0	22.3
West North Central States	235	11.8	12.2
South Atlantic States	226	11.3	15.1
East South Central States	108	5.4	11.1
West South Central States	40	2.0	6.7
Mountain States	26	1.3	1.3
Pacific States	51	2.5	2.3
Total	2,000	100.0	100.0

[2] The figures for the study were secured by taking the first 2,000 persons in "Who's Who for 1914–15," born in the United States since 1869. This was somewhat more than half of the total number of such names appearing in the volume.

"Who's Who" is published in Chicago. The editor, Albert Nelson Marquis, was born in Ohio. "The standards of admission to 'Who's Who in America' divide the eligibles into two classes: (1) Those who are selected on account of special prominence in creditable lines of effort, making them the subjects of extensive interest, inquiry or discussion in this country; and (2) those who are arbitrarily included on account of official position—civil, military, naval, religious or educational—or their connection with the most exclusive learned or other societies." From a statement following the preface, 1914–15 edition.

The real interest in Table I. centers in the relation between the number of people living in a given geographic area and the group of distinguished men produced by this geographic area. Thus New England, with 8 per cent. of the total population of the United States in 1880, produced 16 per cent. of the group of distinguished persons under consideration. The Middle Atlantic states, with 21 per cent. of the population, produced 25 per cent. of the distinguished persons. The East North Central states, with 24 per cent. of the distinguished persons, report only 22 per cent. of the population. The Pacific states, with 2.5 per cent. of distinguished persons, contain 2.3 per cent. of the population. These four sections produced a percentage of distinguished persons greater than the percentage of the total population living within their boundaries. The Mountain states show the same percentage of population and of distinguished persons. The West North Central states, and all of the group of Southern states show a proportion of distinguished persons considerably less than the proportion of the population.

A map of the United States drawn to represent the relation between population and the production of distinguished persons would show New England considerably in the lead, with a proportion of distinguished persons twice as great as her proportion of the population. The Middle Atlantic and East North Central states, while producing a far lower proportion of distinguished persons than New England, produced a far higher number. These three groups of states combined are responsible for two thirds of all the distinguished persons included in this study.

The variation in individual states is considerable. The dominance of the New England states is still evident, though not so marked as it was in the study of 10,000 distinguished native-born persons from the volume of "Who's Who" for 1912–13. From that study it appeared that each one of the New England states individually reported a higher proportion of distinguished persons than any other state in the United States. This situation no longer exists with regard to the younger persons of distinction. Thus, while the number of distinguished persons per 100,000 population in 1880 was 3.9 for the United States, for Maine it was 4.8; New Hampshire, 8.9; Vermont, 5.4; Massachusetts, 10.4; Rhode Island, 8.3; Connecticut, 6.6. Thus each one of the New England states was ahead of the number for the entire country. At the same time, 3 states reported a higher number of distinguished persons per 100,000 population than the lowest New England state (Maine). These states were New York, 5.8; California, 5.1; Maryland, 5.0. New Jersey reported the same number as Maine, namely, 4.8. The fact remains that each of the New England states except Maine reports a higher number of distinguished persons than any other state in the

United States, while Massachusetts, New Hampshire and Rhode Island show a number of distinguished persons nearly twice as great as any other state in the United States.

Another issue is raised when the problem of city environment is considered. The recent developments of city life incident to the growth of the modern industrial world have thrown increasing emphasis upon the necessity for shaping city requirements to meet human needs.

There is a general supposition that the country boy has an advantage over the city boy. That this was not true in the earlier decades was shown very clearly in the study of 10,000 distinguished Americans. The 27 cities which reported a population of more than 20,000 in 1850 contained approximately one eighth of the population, but reported a quarter of the total eminent persons. The same thing is true of the distinguished persons born since 1869.

TABLE II

NUMBER AND PER CENT. OF EMINENT PERSONS BORN IN CITIES HAVING A POPULATION OF 25,000 OR OVER IN 1870, TOGETHER WITH THE PER CENT. OF THE POPULATION LIVING IN THOSE CITIES 1870

	Number	Per Cent.
Total persons	2,000	100.0
Born in cities	640	32.0
Total population of the United States living in those cities, 1870	5,723,496	14.8

Among the 2,000 distinguished persons under consideration, 640, or 32 per cent., were born in the 50 cities reporting a population of 25,000 and over in 1870. These cities in 1870 contained 5,723,496 persons, or 14.8 per cent. of the total population of the United States in 1870. In other words, the proportion of distinguished persons born in the later decades is higher for city environment than appeared in the earlier decades.

The records for individual cities compared with the records for the country at large are indeed remarkable. The number of distinguished persons per 100,000 population in certain of these cities was as follows:

The fecundity of certain cities in distinguished persons is indeed surprising. Cambridge, with 47.5 per 100,000, is far in the lead. Nashville, the second city, with 34.9, again has a considerable advantage over Columbus, Ohio (25.6), and Lynn, Mass. (24.8). Washington falls in as city number five, with a record of 20.2. After this point the cities range themselves with some degree of equality.

The cities which show the highest proportion of distinguished persons per population are not the large cities. Indeed, the large cities occupy a place of distinct inferiority in this respect. Throughout this table of individual cities it is evident that no particular section occupies

TABLE III

NUMBER AND PROPORTION OF DISTINGUISHED PERSONS BORN IN CERTAIN CITIES

Geographical Area	Total Distinguished Persons	Per 100,000 Population 1880
United States	2,000	3.9
Philadelphia	61	7.2
San Francisco	18	7.7
New York City	151	7.8
Baltimore	26	7.9
Buffalo	10	8.0
Richmond	6	9.1
Pittsburgh	13	9.3
Milwaukee	7	9.8
Louisville	10	9.9
Cincinnati	22	10.2
Worcester	6	10.3
Savannah	3	10.8
Detroit	9	11.3
Providence	12	11.4
Newark	14	13.4
Chicago	45	15.1
Kansas City	5	15.4
New Haven	8	15.7
Boston	41	16.3
Portland, Me.	6	17.7
Hartford	7	18.9
Washington	36	20.2
Lynn	7	24.8
Columbus	8	25.6
Nashville	9	34.7
Cambridge	19	47.5

a position of importance. Thus the leading city is in Massachusetts; the second most prominent city is in Tennessee. Most of the cities are, of course, taken from the northern tier of the country, because most of the cities of the country are in this tier; but the southern section in proportion to the number of its cities is well represented.

The proportion of eminent persons born in cities seems to be higher in the later than in the earlier decade. Thus in the decade from 1870 to 1879, 31.3 per cent. of the total distinguished persons were born in the cities; and in the next decade, 1880 to 1889, 36.5 per cent. were born in cities; while the only two persons born between 1890 and 1899 whose names appear in "Who's Who in America" were of city origin.

The supremacy of the cities over the rural districts is well illustrated by a consideration of the relation existing between place of birth and occupation. It should be borne in mind that the 50 cities which reported a population of 25,000 or over in 1870 contained about one seventh of the total population of the country in that year. The per cent. of city-born persons in certain occupations appears in the following table:

TABLE IV

NUMBER AND PER CENT. OF EMINENT PERSONS, CLASSIFIED BY OCCUPATIONS, WHO WERE BORN IN CITIES

Occupations	Total Persons	Born in Cities	Per Cent. Born in Cities
All occupations	2,000	640	32.0
Educators	467	117	25.0
Authors	232	91	39.2
Public Office Holders	216	58	26.9
Scientists	241	60	24.9
Business Men	156	65	41.6
Lawyers	138	50	35.9
Journalists	125	41	32.8
Doctors	102	34	33.3
Clergymen	68	13	19.1
Actors	41	18	43.9
Miscellaneous	214	93	43.4

The clergymen report the smallest percentage of city origin, falling to one fifth. The highest proportion, for actors and authors, show more than two fifths of city origin. Business men appear in almost the same class. A third of the lawyers, journalists and doctors are born in the city, while a quarter of the educators, public office holders, and scientists are of city origin. In every occupation, with the exception of clergymen, the proportion of persons of city origin is far greater than the relation between city and rural population would seem to warrant.

The younger generation of distinguished Americans were born in the north and east sections of the United States. Although the lead of New England is not so pronounced as it was in the earlier decades, it is still considerable. These persons were born in cities. The large cities of the United States, containing a seventh of the population, produced a third of the younger generation of distinguished Americans. The leaders of American life are still coming from a small area in the northeastern part of the United States, and particularly from the cities there.

3. THE TIME OF BIRTH

Little can be said about the period of birth of the distinguished persons under consideration, because almost nine tenths of them were born within the decade between 1870 and 1879. Since the group under consideration must necessarily be less than forty-five years of age, the earlier decade would naturally contain most of them.

TABLE V

NUMBER AND PER CENT. OF EMINENT PERSONS WHO WERE BORN AT CERTAIN PERIODS

	Number	Per Cent.
1870–79	1,771	88.5
1880–89	227	11.4
1890–99	2	.1
Total	2,000	100.0

4. Education

The chief advantage ascribed to New England by many of the critics of the previous study lay in her educational system. Although it was impossible to secure from the biographical records in "Who's Who" any satisfactory statement of the common-school education, there was a very general record of college attendance. The figures showing college affiliation are significant.

TABLE VI

College Affiliation of Eminent Persons

	Number	Per Cent.
No college affiliation	263	13.1
Attended, but did not graduate	190	9.5
Holders of degrees	1,547	77.4
Total	2,000	100.0

More than three quarters of the younger generation of eminent persons are college graduates. The caption, "No college affiliation," may include certain persons who graduated from college but failed to state the fact when they made out their biographies. Almost nine tenths report some college affiliation. Among the younger group of distinguished Americans a college education seems to be a recognized necessity.

For a century the New England and Middle Atlantic states were the home of colleges. Does the fact have any marked effect on the extent of college affiliation? The following table seems to answer the question in the negative:

TABLE VII

College Affiliation of Distinguished Persons Classified by Geographical Area

Geographical Area	Total Persons	No College Affiliation	Per Cent. Having No College Affiliation
New England	331	38	11.5
Middle Atlantic States	503	78	15.5
East North Central States	480	60	12.5
West North Central	235	31	13.2
South Atlantic States	226	25	11.1
All other	225	31	13.8
Total	2,000	263	13.1

The per cent. of distinguished persons having no college affiliation does not vary greatly from one geographic area to the other. It is highest in the Middle Atlantic states, and lowest in the South Central states.

The figures for individual colleges are, however, significant, suggesting again that there is a certain carrying power in vested culture which

is a large asset in the success of the individual who comes into contact with it. Although the figures for individual colleges were in a sense unsatisfactory because they were so scattering, in another sense they were profoundly significant.

TABLE VIII

NUMBERS OF DISTINGUISHED PERSONS GRADUATING FROM CERTAIN SPECIFIED COLLEGES

Harvard	155	U. of Wisconsin	29
Yale	83	Stanford	28
Columbia	52	Massachusetts Institute of Technology	28
Michigan	44	Johns Hopkins	26
Cornell	36	U. of Chicago	26
University of Pennsylvania	36	U. of California	25
Princeton	34		

The persons under consideration were born since 1869. They were therefore graduated for the most part since 1890. If the figures had reference to the middle of the nineteenth century, it might readily be taken for granted that they would pile up in certain of the older colleges; but these graduations have all occurred since 1890, in the age of many colleges. Nevertheless, the piling-up process is evident.

Harvard leads the race and, save for Yale, she has not even a respectable competitor. Among the 2,000 distinguished persons of the younger generation, Harvard has graduated almost as many as Columbia, Cornell, Pennsylvania and Michigan combined; almost as many as Columbia, Cornell, Pennsylvania and Princeton combined; almost as many as Wisconsin, Stanford, Massachusetts Institute of Technology, Johns Hopkins, Chicago and California combined. Harvard and Yale together have graduated 24 more of these distinguished persons than Columbia, Cornell, Pennsylvania and Princeton combined. The supremacy of these two institutions, and of Harvard in particular, is little short of astounding.[3]

The effectiveness of these two institutions becomes even more remarkable when account is taken of the geographical distribution of their graduates. Most of the colleges listed show a great majority of localized graduations. Thus among 52 distinguished graduates at Columbia, 34 were born in the Middle Atlantic states; among 34 at Princeton, 20 were born in the Middle Atlantic states; among 25 at California, 19 were born in the Pacific states; among 44 at Michigan, 33 were born in the East North Central states. The contrast between these institutions and Harvard and Yale is strongly brought out in the following table:

[3] The writer is not a graduate of Harvard or Yale, and has never had any official relations with either institution.

TABLE IX

PLACE OF BIRTH AND COLLEGE AFFILIATION OF DISTINGUISHED PERSONS, FOR CERTAIN COLLEGES

Born in	Graduated from				
	Harvard	Yale	Columbia	Michigan	Cornell
New England States	78	27	5	2	—
Middle Atlantic States	33	23	34	3	22
East North Central States	27	15	7	33	7
West North Central States	6	8	1	2	4
All other	11	10	5	4	3
Total	155	83	52	44	36

Yale, even more than Harvard, seems to have drawn her distinguished alumni from all parts of the country, and both of these colleges have done this in a unique way that is without parallel among the other colleges for which returns were tabulated, with the single exception of Stanford.

The dissenter will argue that the very fact of the wide geographical distribution of the distinguished persons from Harvard and Yale is a proof that the pick of prospective college students, from all sections, choose Harvard and Yale. At the same time, something must be said for the power which an ideal of culture may exert. If it is true, as many historians assert, that the spirit of Athens and Rome kindled the fires of genius in their sons, then it may be equally true that the spirit at Harvard and at Yale kindles the fires of genius in their sons. Culture is a power. Somewhere it must be centered. Both the studies of distinguished Americans which are under consideration seem to show a high pressure area of culture over New England, and centering in her great institutions of learning.

5. Occupations

The persons whose names appear in "Who's Who in America" are almost wholly professional people. Among the 38,167,336 gainfully occupied persons in the United States in 1910, 4 in each hundred were in professions; yet among the 2,000 distinguished persons under consideration, 80 in each hundred were in the professions. Either it is true that professional people make up the bulk of distinguished persons in the community, or else the people who are named from "Who's Who" are picked from the professional classes. Experience would lead to the belief that the leaders are picked from the professional classes.

Educators are far in the lead among the occupational groups. Indeed, they contribute nearly a quarter of the total, and almost twice as large a group as the scientists, who rank next. Authors and public office holders rank close together. The rear is brought up by the learned

TABLE X

NUMBER AND PER CENT. OF EMINENT PERSONS BORN SINCE 1869 IN CERTAIN OCCUPATIONS

	Number	Per Cent.
Educators	467	23.4
Scientists	241	12.1
Authors	232	11.6
Public Office Holders	215	10.8
Business Men	156	7.8
Lawyers	139	6.9
Journalists	125	6.2
Doctors	102	5.1
Clergymen	68	3.4
Miscellaneous	255	12.7
Total	2,000	100.0

professions—lawyers, doctors and clergymen. These three groups, with the journalists, make up a less percentage than the educators alone.

The real surprise in the occupation figures arises out of a comparison between the occupations of the persons of all ages, studied in the "Who's Who" for 1912–13, and the persons born since 1869, included in the present study. Some of the differences existing between the two groups are striking.

TABLE XI

PER CENT. OF PERSONS IN VARIOUS OCCUPATIONS AS APPEARING IN "WHO'S WHO" FOR TWO PERIODS OF TIME

	First 10,000 Native-born Persons in "Who's Who" 1912–13	First 2,000 Persons Native-born Since 1869, "Who's Who" 1914–15
Educators	19.3	23.4
Lawyers	13.6	6.9
Public Office Holders	13.5	10.8
Business Men	9.9	7.8
Authors	9.1	11.6
Clergymen	7.3	3.4
Doctors	6.2	5.1
Scientists	6.1	12.1
Journalists	6.0	6.2
Miscellaneous	9.0	12.7
Total	100.0	100.0

The gains are made by educators, authors and scientists. Scientists, in particular, have doubled their percentage. The greatest decline is shown by clergymen and by lawyers. It seems a little surprising that there should have been a decrease in the proportion of business men.

There is always a possibility that the method of selecting names for the "Who's Who" volume may have changed of late years in a way to place greater emphasis on some occupations, and less on others. At

the same time, daily experience verifies most of the showings made by these figures.

Apparently, community leadership expresses itself through the professions, preeminently. At the same time, during recent years there is a rapidly changing significance in professions. Educators, scientists, authors, public officials and business men now make up the body of leadership. The old-time learned professions comprise a comparatively small element in the whole group of distinguished Americans.

6. The Sex of Distinguished Americans

The most impressive fact which the study of sex distribution among distinguished Americans brings to light is the phenomenally small proportion of women whose names are included. Among the first 2,000 names of American-born persons appearing in "Who's Who in America," only 169 are the names of women.

There is no section of the country in which the number of women approaches that of men. There is considerable variation. The number of women per hundred men is higher in the west than in the east, and higher in the north than in the south. At the same time the ratio is at best extremely low.

TABLE XII

Sex Distribution among the Younger Generation of Distinguished Americans by Geographic Areas

	Total	Men	Women	No. of Women per 100 Men
New England	331	292	39	13
Middle Atlantic States	503	453	50	11
East North Central States	480	448	32	7
West North Central States	235	222	13	6
South Atlantic	226	214	12	6
East South Central States	108	100	8	8
West South Central States	40	34	6	17
Mountain States	26	24	2	8
Pacific States	51	44	7	16
Total	2,000	1,831	169	9

The names of women appear very unequally in the various occupations.

The women listed among the first 2,000 names in "Who's Who" constitute 8.4 per cent. of the whole. There are four occupations as classified in Table XIII. for which the distinguished women are practically non-existent, and two others in which they make but a sorry showing. Lawyers, business men, public office holders and clergymen include 577 men, or 32 per cent. of the total number of distinguished men. The same four occupations report 1 woman, or 0.5 per cent. of

the distinguished women. Add to these four occupations doctors and scientists, and the aggregate of the six occupations is 915 (50 per cent. of all distinguished men). The same six occupations report only 6 (3.5 per cent.) of the distinguished women. The six occupations—lawyers, business men, public office holders, clergy, doctors, and scientists—report 915 distinguished men and 6 distinguished women—a ratio of 0.6 women to 100 men.

TABLE XIII

SEX DISTRIBUTION OF FIRST 2,000 AMERICAN-BORN PERSONS APPEARING IN "WHO'S WHO" FOR 1914–15 WHO HAVE BEEN BORN SINCE 1869—BY OCCUPATION

Occupation	Total	Men	Women
Lawyers	139	138	1
Educators	467	450	17
Business	156	156	—
Scientists	241	238	3
Clergymen	68	68	—
Authors	232	157	75
Public Office Holders	215	215	—
Journalists	125	117	8
Doctors	102	100	2
Actors	42	16	26
Miscellaneous	213	176	37
Total	2,000	1,831	169

The great bulk of the distinguished women listed among the first 2,000 native-born persons in "Who's Who" are educators, authors or actresses. These three occupations, with 623 distinguished men (34 per cent. of the total number), have 118 distinguished women (70 per cent. of the total number). In these three occupations, therefore, the ratio of women to men is 1 to 5.

The one occupation of considerable magnitude in which women approach men is that of author. Of the 232 authors listed among the first 2,000 American-born persons in "Who's Who," 75 (32 per cent.) are women. At the same time, the 75 women authors comprise almost one half of all of the distinguished women whose names appear in "Who's Who."

This showing takes on peculiar significance in view of the fact that until within the last thirty or forty years women were practically excluded from law, public office, the ministry, medicine and higher education, while they were admitted with some degree of freedom to the fields of education and journalism, and could not, in the very nature of the case, be excluded from authorship. It may be true, as some students urge, that women are peculiarly adapted to emotional activities, of which certain lines of literary achievement are typical. At the same time, the searcher after truth may point with equal justification to the

fact that women occupy a position commensurate with that occupied by men in the one profession where they have been given an opportunity.

The figures dealing with the decade of birth lend emphasis to the idea that the failure of women to attain positions of distinction has been due, in the past, to the restriction in opportunity.

Women have been free to enter upon careers that led to public distinction only within the past thirty or forty years. Extensive higher education for women does not date back more than twenty or twenty-five years.

TABLE XIV

SEX DISTRIBUTION OF FIRST 2,000 PERSONS IN "WHO'S WHO IN AMERICA" (1914–15) WHO HAVE BEEN BORN SINCE 1869

Decade	Total	Men	Women	Women per 100 Men
1870–79	1,771	1,638	133	8
1880–89	227	192	35	18
Born since 1890	2	1	1	100
Total................	2,000	1,831	169	9

Among the distinguished persons born between 1870 and 1879 there are only 8 women per hundred men. In the next decade this number increases to 18, more than double; and in the last decade, where of course the figures are so few as to be wholly undependable, the ratio is even. The later figures will undoubtedly show an increase in the ratio of women to men.

7. CONCLUSIONS

The facts regarding the place and time of birth, education, occupation and sex of the younger generation of distinguished Americans lead to some rather significant conclusions. New England, though no longer supreme, is still distinctly in the ascendant as a producer of American leadership. The leadership comes out of the cities to a far greater degree than it does from rural districts. In certain cities, like Cambridge and Nashville, the fecundity in distinguished persons is exceptional. Among the persons listed in "Who's Who" who were born after 1869, the great majority were born in the decade 1870–79. The younger generation of distinguished Americans consists almost wholly of college graduates. In the list of colleges which have educated these distinguished persons, certain institutions, notably Harvard and Yale, stand out preeminently as trainers of leadership. The old learned professions—law, medicine and the ministry—are losing very rapidly in favor of science and education. There has been a revolution in the source from which community leadership is secured. The younger generation of distinguished Americans is overwhelmingly male; only a

few women have pushed into the ranks, and they are found in only three professions.

The tendencies which were noted in the earlier study of distinguished Americans appear in this later study—some less, and some more marked. Leadership arises even in this last generation from one half of the population, the men; from one small group of the population, the college-bred; from one small geographic area, the northeastern section of the United States; from one small group of occupations, the professions.

MUSEUM FATIGUE

By BENJAMIN IVES GILMAN
BOSTON MUSEUM OF FINE ARTS, BOSTON, MASS.

THE museum in which the photographs here reproduced were taken no longer exists; but the conditions depicted are still well-nigh universal. The museum was the first Museum of Fine Arts in Boston, of which the present great structure on the Fenway became in 1909 the successor. The conditions are those resulting from the type of museum case and of museum installation widely accepted as standards among us.

The photographs were taken with the object of determining by actual observation just what kinds and amount of muscular effort are demanded of the visitor who endeavors to see exhibits as museum authorities plan to have them seen. "Museum fatigue" is an admitted evil, hitherto tacitly accepted as admitting only relief. May not a study of how it comes about suggest some means of prevention?

The method adopted in the inquiry was the following. A series of simple questions was devised relating to certain objects mostly installed at higher or lower levels and in cases; and an observer was photographed in the act of answering them. The observer, an intelligent man with good eye-sight, and well accustomed to museums and their contents, was instructed to answer the questions with the least possible exertion and to hold the positions he needed to assume for the purpose until he could be photographed.

The pictures obtained indicate that an inordinate amount of physical effort is demanded of the ideal visitor by the present methods in which we offer most objects to his inspection. It is at once evident that these methods form an effective bar to the adequate fulfilment by museums of the public function they aim to perform. Not even the hardiest sight-seer will long go through with the contortions which the pictures indicate are needed for any comprehension of much of what we display to him. After a brief initial exertion he will resign himself to seeing practically everything imperfectly and by a passing glance. If the public is to gain more than a minute fraction of the good from museum exhibits which is theirs to give and which now can be gained by the private student, radical changes in our methods of exhibition are imperative. As at present installed, the contents of our museums are in large part only preserved, not shown.

Indeed, we may even go further and claim that in some proportion of the objects put on public view in every museum the qualities for which they are shown are rendered wholly invisible by the way they are shown. They are so placed and in such lighting that it is a physical

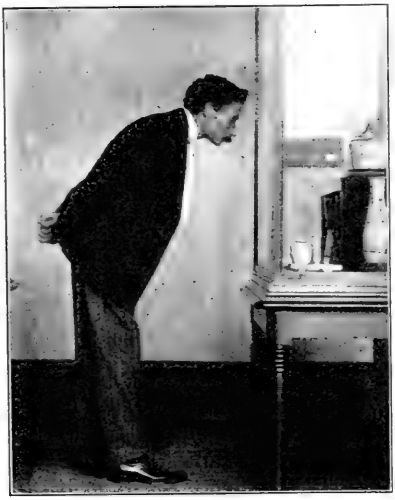
impossibility by any exertion of limb or eye to descry the particular characteristics to which they owe their selection for show. This is literally an absurd state of things; yet there would be little risk in offering to point out to any museum curator objects so concealed by their installation in his own museum.

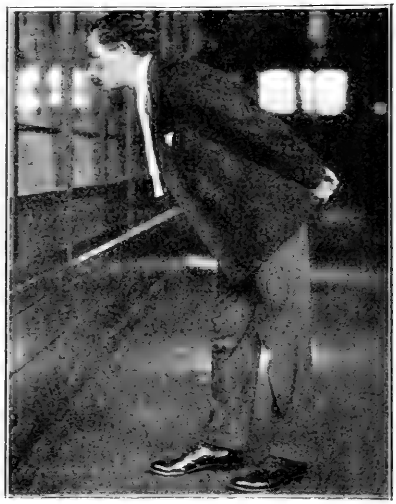
On the other hand, a proportion of the objects in every museum may be adequately seen without any marked exertion. These are the instances in which objects are installed approximately on a level with and near to the eye of the visitor as he stands upright before them. They constitute a minor fraction of museum installations, and are not represented in the accompanying illustrations. Our present purpose is to inquire into the larger proportion of instances in which adequate seeing demands exertion.

The questions and answers here follow, grouped according to the types of attitude represented in the illustrations. The cases called floor cases are from six to seven feet high, two and one half to three feet broad, five feet long, with a main floor at about thirty inches from the ground, and supported either on legs or on a closed lower compartment.

These pictures indicate that the principal sources of that part of museum fatigue which comes from muscular effort to see objects well are two: (1) low installations in upright cases; (2) broad installations in flat or desk cases. High installation may put objects out of sight, but is a minor source of fatigue; while to bring the eye within seeing distance of low shelves is apt to demand bending the knees; and the effort to see objects at the back of wide desk or flat cases requires bending at the hips. The pictures indicate further two ways in which objects may be exhibited in museum cases so as to make invisible some or all of the features which warrant their exhibition. They may, first, be concealed in part by others. They may, second, be placed too far back from the glass to be seen in the necessary detail. The effort of the eye muscles can not be directly shown in pictures, but is evidently considerable and may be hopeless.

The inferences are that museum fatigue would be greatly helped were upright cases to stand higher, flat and desk cases to be made narrower, and all cases shallower from front to back. This shallowing would put an end to the concealment of one object by another by putting an end to the exhibition of multiple rows of objects on the same shelf. All cases would be single row cases. The shallowing would further bring all the contents of a case within the limits of close scrutiny. These inferences from the present experiment may be made more precise by others based on measurements of the human body and of the contents of museum shelves. Estimating the height of the average visitor at sixty-three inches, his eye will be about sixty inches above





I. *Bent.* (*a*) *Hands behind back.*

FIG. 1. *Object.*—An Egyptian panel about six inches square set upright between two jars on a pedestal in the center of a floor case. *Question.*—What is the material of this panel? *Answer.*—Wood.

FIG. 2. *Object.*—Chinese bronze mirrors exhibited in a wall case. *Q.*—Describe the pattern of one of the mirrors in the lowest row. *A.*—A central knob in a square, with knobs about and other patterns.

FIG. 3. *Object.*—A print displayed in a desk case. *Q.*—What are these children running away from? *A.*—A dog.

(*b*) *Hands on knee or otherwise supported.*

FIG. 4. *Object.*—An Egyptian statuette of gold, about three inches high, on a stand on the center pedestal of a floor case, behind an upright lens. The observer was asked to inspect this object and to read its label.

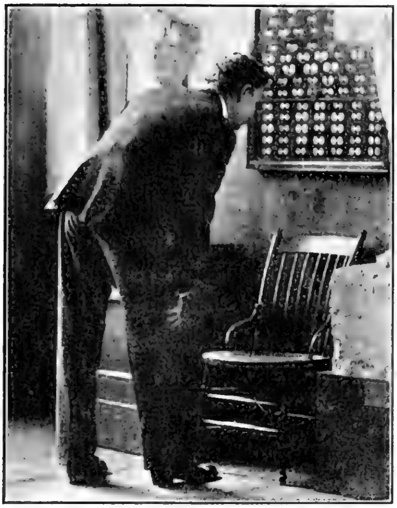
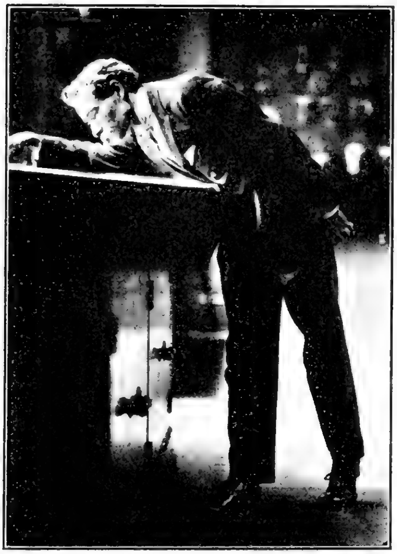


FIG. 5. *Object.*—Electrotype reproductions of Greek coins in a frame hung against the wall. The observer was asked to read the label of a coin in one of the lower rows.

FIG. 6. *Object.*—A painting by Meissonier representing a horseman. The painting was hung on the line. *Q.*—What is represented on the horse's crupper? *A.*—A blanket rolled up.

FIG. 7. *Object.*—A Greek coin exhibited toward the front of a flat case. *Q.*—Describe the device on this coin. *A.*—A cow licking her hind foot.

FIG. 8. *Object.*—Plaster impressions from engraved Greek gems, exhibited in a flat case. *Q.*—The observer was asked to describe the device on one of the gems in the center of the case. *A.*—Two goats.



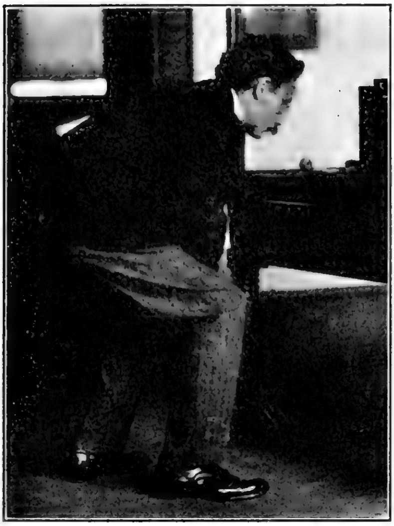
II. ***Much bent.***

FIG. 9. *Object.*—Greek dagger handle with carved top, lying in the center of a desk case. *Q.*—Describe the carving. *A.*—It represents an animal devouring a ram's head.

FIG. 10. *Object.*—A Renaissance crucifix lying on the bottom of a floor case, and bearing an incised design. The observer was asked to describe the design. *A.*—The figure of Christ.

FIG. 11. *Object.*—A fragment of ornament lying on the bottom of a floor case. *Q.* What does the pattern on this fragment represent? *A.*—A group of five persons dancing.

FIG. 12. *Object.*—A cast of the Venus of Melos. The observer was asked to read the label on the pedestal.



III. *Half-crouching.*

Fig. 13. *Object.*—A fragment of a relief on wood lying flat on the bottom of a floor case. *Q.*—What is represented on this relief? *A.*—A bird.

Fig. 14. *Object.*—A crystal ball on a carved metal pedestal in a floor case. *Q.*—What does the pedestal represent? *A.*—Cliffs, with houses and trees.

IV. *Crouching.*

Fig. 15. *Object.*—Engraving after Canaletto in the lower row of a wall-case. *Q.*—Is the space in the center land or water? *A.*—Water.

Fig. 16. *Object.*—Terra-cotta statuette on lower shelf of case. *Q.*—What is this goddess resting her elbow on? *A.*—A smaller statuette bearing a drum-shaped object on its head.

FIG. 17. *Object.*—English posset cup in the base of a floor case. The observer was asked to read the label.

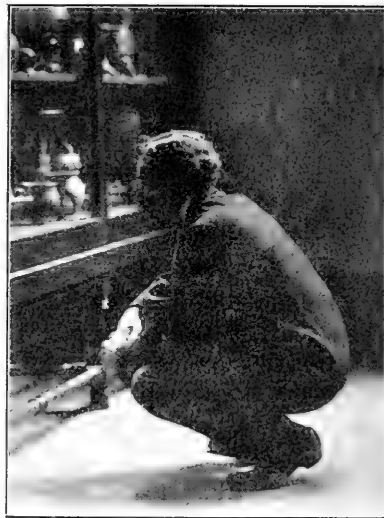


FIG. 18. *Object.*—A Greek vase on lower shelf of case. *Q.*—Describe the design on this vase. *A.*—A rough vine pattern.

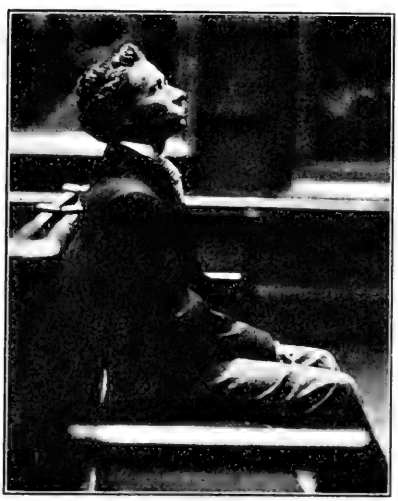
FIG. 19. *Object.*—Cast of the Laocoon. The observer was asked to read the label.

FIG. 20. *Object.*—Drawing of the Propylea on an easel. The observer was asked to read the label.

FIG. 21. *Object.*—Drawing of the sculptures on the western pediment of the Parthenon, installed on the pedestal of the casts reproducing their remains. *Q.*—Describe the figure farthest to the right. *A.*—A youth lying down.

V. *Twisted.*

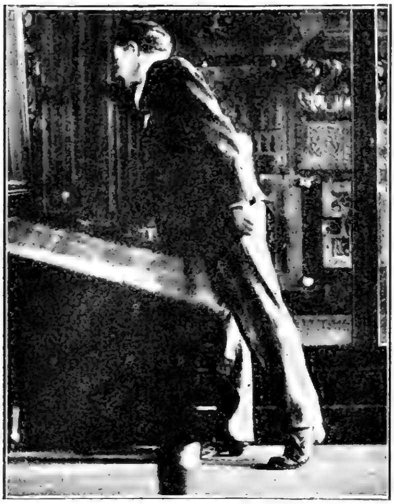
FIG. 22. *Object.*—A fragment of Arretine pottery lying near the end of a desk case. *Q.*—How many musical instruments can be seen in this group? *A.* —two: harp and pipes.



VI. *Looking up.*

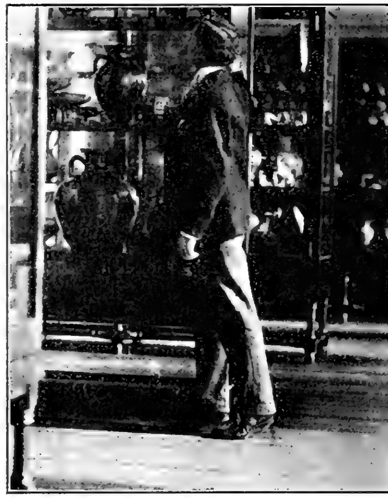
FIG. 23. *Object.*—A landscape hung high. *Q.*—Is the sky clear or cloudy? *A.* —Overcast.

FIG. 24. *Object.*—A textile hanging over a wall case. *Q.*—Has the upper border the same pattern as the lower? *A.* —Yes; but reversed.



VII. *Stretching forward.*

FIG. 25. *Object.*—Statuette on a bracket back of a desk case. The observer was asked to read the label.



VIII. *Stretching up.*

FIG. 26. *Object.*—A vase on upper shelf of case. The observer was asked to read the label and notice the pattern.

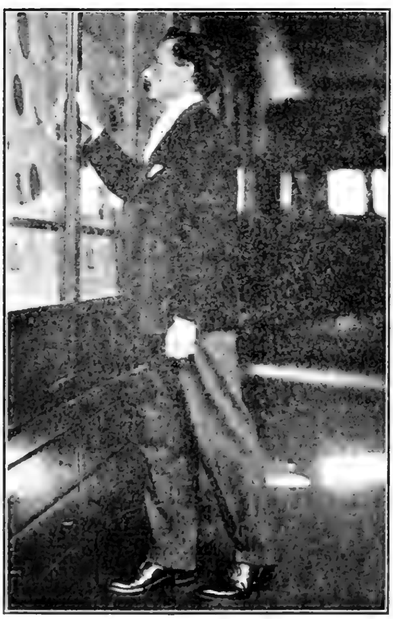


FIG. 27. *Object.*—Chinese bronze mirrors in a wall case. *Q.*—Describe the pattern of one of the mirrors on the top row. *A.*—A central knob in a square with knobs about and other patterns.

FIG. 28. *Object.*—A vase on the back row of the upper shelf of a case. *Q.*—Is there a pattern on the neck? *A.*—Yes; bands of horizontal lines.

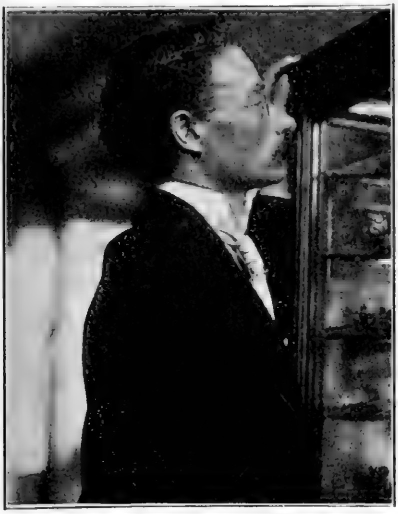
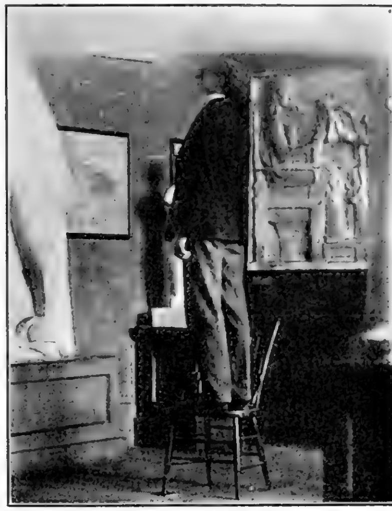


FIG. 29. *Object.*—A small ivory carving (netsuke) on the upper shelf of a floor case. *Q.*—How many wounds are there in this decapitated head? *A.*—Five.



IX. *Climbing up.*

FIG. 30. *Object.*—A cast of a head of Hera hung high on the wall. The observer was asked to read the label. *A.*—I can read the large letters, but not the small.

the floor and his hip joint about thirty-eight or thirty-nine inches. For the minutest inspection of a work of art, as for reading fine print, the eye should not be more than about twelve inches from it. The distance forward of a perpendicular from the feet, to which the eye may easily be carried by bending the body from the hips, is not over about fifteen inches. Of the objects commonly preserved in cases in our museums, but a small fraction, perhaps hardly more than a twentieth, are over twelve inches in diameter. Of objects of the nature of ornamented surfaces in frames or settings, or otherwise needing to be seen only on one side, but a smaller proportion are more than two or three inches from front to back.

From these figures approximate dimensions for cases which shall reduce the muscular effort of good seeing to a minimum may be deduced as follows: the lowest exhibition level for case objects should not be more than eighteen inches below the average eye, or forty-two inches from the ground instead of thirty inches or less, as often at present. This would be the indicated height for the bottom of upright cases and the front level of desk or flat cases. The use of the base compartment of cases for exhibition should be given up. The breadth of flat cases should not be greater than about eighteen inches, instead of twenty-eight inches or more as at present. Desk (inclined) cases may be somewhat wider. Beyond these limits the eye can not easily be brought within close seeing distance of the back of the case. The depth of flat or desk

cases from the glass to the bottom should not be greater than from two to four inches, instead of from six to twelve inches as at present. A depth from front to back of four inches would often also suffice for wall cases, instead of from sixteen to twenty-four inches as at present. Six inches might be regarded as their maximum supposing them used to receive only objects seen to full advantage from one side. The depth of upright floor cases from front to back should not exceed twelve inches. A smaller standard depth of eight inches would probably also be found useful. Upright floor cases or wall cases might be eighty-four inches high instead of one hundred or more as at present. It is true the bottom of an object twelve inches high installed at the top of such a case with three inches above to spare would be six inches above the average eye, and the top eighteen inches. But since, on the twelve-inch shelf assumed, all parts of the object would be within six inches of the glass, it would all be within practicable seeing distance, although only the lower part could be closely examined.

The stability of floor cases a foot or less in breadth and seven feet high would require to be secured by special means. If the legs were perpendicular, they would need to be fastened to the floor, otherwise they would need a wider bearing by extended feet; or a removable bar at the top of the case connecting it with another might be given a design in harmony with their framing and join the two into a stable pair.

One result of the use of shallower cases would be that there would be less waste space within them. At present the space within a floor case of the usual broad dimensions is only very partially used. The exhibit is generally arranged in a pyramidal form of which the lower levels are seen against the successive steps of an interior pedestal and only the top row is shown above it and can be seen on all sides. All the space above the lower rows of objects is empty. In the narrow case proposed there would be in general no pedestal, but shelves alone. There would be no empty space above any row of objects and every object would be visible from all sides. Since a larger number of cases could be placed in a given area, another result would be that a greater proportion of museum objects would be exposed to view on all sides. An economy of case-space would be coupled with a completer showing of case-contents.

Such changes would make a radical difference in the appearance of museum galleries. They would be fitted with a number of small cases, very shallow and standing but not reaching high, instead of a few large ones, broad, set low and rising higher. Wall cases would shrink to one quarter their present depth, upright floor cases to one third their present depth and to a less average height, and desk and flat cases to three quarters their width and one third their vertical depth. Delicate,

instead of heavy, construction would be the rule. The exhibits would be shown spaced and unobstructed instead of grouped into decorative pyramids or serried ranks. The small fraction of objects which are over twelve inches in diameter would be installed either in the open or each in its separate case.

Nevertheless, there would remain opportunity within the cases for the more or less advantageous showing of more or less meritorious objects. The upright cases on the floor and the wall would still have a *piano nobile,* or main level, in the space directly opposite the eye. Between a bottom at forty-two inches above the floor and a top at eighty-four inches, there would be forty-two inches of space which, if divided by two shelves giving three spaces about fourteen inches each, would offer three gradations of prominence: first, the middle at fifty-six to seventy inches, because seen without effort by the average eye at sixty inches; second, the lowest, because perfectly seen at forty-two to fifty-six inches by inclining the body a few inches; and third, the uppermost, from seventy to eighty-four inches, because seen simply by raising the glance, although inaccessible to the closest inspection. If divided by a central shelf at sixty-three inches, the upper space of twenty-one inches would be the *piano nobile,* because the lower and generally more important part of the object would be open to close inspection without fatigue. On the under shelf, only the upper and generally less important part of an object could be studied without bending.

In cases such as these museums would, for the first time, possess veritable show cases. Hitherto these indispensable protective devices have in reality been glazed storage chests valuable primarily for their capacity. Their wide shelving with double or triple or multiple rows of objects is a survival from the days when museums were thought of as magazines where things were kept in safety ready for inspection when needed. Such shelving has no real place in these days of serious attempts to deal with the problems of public show.

The present argument is not the first that has been offered in support of narrow cases; nor are they unknown in newer museum installations. Mr. Lewis Foreman Day wrote a few years ago:

> Museum cases are nearly always too big—and especially they are much too wide.

One argument against deep cases is:

> that the things at the back of them (and in the center of square cases) are reduced to background. Another is, you can not get close enough to see things properly. . . . Think what a big vase you can put on a mantel-piece from nine to twelve inches wide, and you will realize how seldom it is necessary to have cases much wider than that. . . . Some of the cases at Munich are not more than nine inches deep, and it is astonishing the size of the objects they hold.[1]

[1] Lewis Foreman Day, F.S.A., "How to Make the Most of a Museum," *Journal of the Society of Arts,* January 10, 1908, p. 153 f.

The smaller shelf-widths which Mr. Day notes at Munich have come into occasional use also in other museums, American and foreign. In Boston the show-space tends also to be set higher.

The reduction in the cubic contents of museum cases here advocated, in harmony with Mr. Day's suggestion and newer practice, is the second radical improvement in these fixtures since public museums were instituted. The first is an improvement from the point of view of the museum; the second from the point of view of the visitor. The device known in Europe as the Reichenberger case (due to Dr. Gustav E. Pazaurek, Director at the time of the North Bohemian Museum of Industrial Art), and in America as the Boston case (independently invented with a different mechanism by Mr. W. W. MacLean of the Boston Museum), consists in opening a case by lifting its top with a windlass instead of unlocking its doors with a key. This was a proposal in the interest of the security of the contents from dust, damp and theft. The reduction of the size and particularly of the depth of cases is a proposal in the interest of the easy visibility of their contents. By making also this second advance in the construction of these necessary fixtures, the museum would be in a position to fulfill more perfectly both of its essential functions, first as guardian and then as expositor of the treasures committed to its charge.

The use of smaller cases has for a corollary a reduction in the number of objects shown simultaneously. It would be another step in the pathway which modern museums have already entered upon in dividing their contents into show and study series and in alternating objects between the two. The era of smaller and changing exhibits is also an era of better exhibition.

THE FUNCTION OF MILK IN THE SCHEME OF EVOLUTION

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GOETHE once remarked that blood is a very peculiar juice. We can say the same of milk. Modern physiological researches have shown that certain glands and secretions of the body have much larger functions than have hitherto been assigned to them. We need only refer to the so-called "internal secretions" of various glands, formerly unrecognized, that are now known to exert a marvellous influence not only on physical life, but on mental development as well.

These facts have led us to give a closer scrutiny to the more familiar fluids of the body, of which milk is one of the best known, as it constitutes the universal food for the young of all mammalia. In serving this most important function it is recognized as a complete food, containing in itself all the elements required to support life. These include protein for growth and tissue repair, with mineral salts to aid in this function; carbohydrates and fats that produce heat and energy, and an abundance of water so necessary to carry on all the processes of life. From a nutritional standpoint, it is thus a perfect food, and all milks are alike in this respect. While each species of mammalian young is perfectly nourished by the milk of its own mother, the food elements are present in varying proportions in different species, this depending largely on the rapidity of growth of the offspring.

Another peculiarity common to all milks is that when collected from the mother they are always in fluid form, but as soon as taken into the stomach of the young they become more or less solid. This is due to a process of coagulation that takes place only in one of the ingredients—the protein—but which thus always alters the form of the ingested milk. While the carbohydrates and fats in their composition and reaction to the digestive secretions are a good deal alike in different milks, the proteins are essentially different. It is further to be noted that coagulation of the proteins of milk takes place in different degrees in the different species.

We are now led to two queries: (1) What is nature's object in presenting a fluid that always coagulates in the stomach that receives it, and (2) Why do the milks of different species coagulate in different ways? An answer will be found in studying the relation between the milk and the particular digestive tract that is destined to receive it. While a certain portion of the protein of all milks coagulates on coming in contact with rennin or rennin and acid, the manner and extent of

the coagulation will stand in a direct relation to the proper evolution of the digestive tract of the animal.

While there are many grades of coagulability in the milks of different animals, we may for practical purposes distinguish three of these grades and consider their significance. The protein may coagulate in a solid, gelatinous or flocculent manner. In the ruminant herbivorous animals, such as the cow, sheep or goat, the protein coagulates in solid, tough masses that can not readily escape from the stomach. In these animals, digestion is always largely gastric and the stomach forms seventy per cent. of the digestive tract. Later on, this stomach will be called upon largely to digest tough, stringy masses of hay and straw and the previous exercise on the tough curds of the milk develops it for this future work.

In the non-ruminant herbivora, such as the mare and ass, the protein coagulates in gelatinous masses that can easily leave the stomach. There is an object in thus passing the curds quickly along, as in this class of animals digestion is largely intestinal, and the intestines form about ninety per cent. of the digestive tract. Later on, grasses and grain must be largely digested in the intestinal portion of the tube, and hence the curd is here also especially adapted to develop a certain part of the intestinal tract for its future work.

In human milk the curd is thrown down in flocculent masses—a form intermediate between the solid and gelatinous types of curd previously noted. While digestion begins in the stomach, it is largely carried on and completed in the intestine, and the stomach forms only about twenty per cent. of the digestive tract. The curd is thus adapted to start the development and motility of the stomach, and finishes by instituting these functions in the bowel which is destined to play a predominant part in digestion. Here again the curd, as far as form is concerned, furnishes, to a certain extent, an analogue and precursor of the future food of the infant. The curd forms small, flocculent masses, and the future food must be separated later into small particles by chewing before digestion can take place to the best advantage.

We have thus seen that the milk of herbivorous animals, whose digestion is principally gastric, forms solid curds that can not easily leave the stomach; that the milk of herbivorous animals whose digestion is principally intestinal, forms gelatinous curds which easily leave the stomach and pass into the intestine; and that woman's milk, which is intended for a digestive system in which gastric digestion is more than that of the horse or ass, but not so great as the cow or goat, curds in flakes that stand between the other two types of curds. Hence it is a law that coagulation of the proteins of milk always takes place in such a way as to most readily adapt the digestive tract for its future work, as this function needs special preparation. It is thus seen that while a

certain amount of protein is present in the milk of all animals and is necessary for tissue building and growth, this protein must not only be coagulable, but must curd in a *certain specific way* in each species of animal for the proper evolution of their digestive tracts.

In studying the life history of animals it is observed that all commence life in an exceedingly simple form, and for a time their development proceeds along lines so nearly parallel that it is impossible to determine to what species the embryos belong. As development proceeds, a divergence of form and structure is noticeable. At birth this divergence is so great that there is no difficulty in distinguishing species, but the variation in the functions in nutrition at this time is not very great, especially in mammals.

The milks of different mammals at birth can be made interchangeable for many individuals of the young of various species, and, as far as nutritive value is concerned, they are often fairly satisfactory substitutes for each other. But at the end of the natural suckling period of many mammals, no such interchange of food would be possible. To realize what a divergence in the digestive functions has been taking place during the suckling period, imagine an infant, a kitten and a calf all being fed successfully on cow's milk. Here it is evident that at the very beginning of life the difference in their digestive processes is not very great; but wait a year until all three have passed the suckling period. The infant will be just beginning to eat soft food, the kitten will have developed so that it can eat flesh and bones, and the calf will be thriving on grass and hay. In one short year the divergence of their digestive tracts has been so great that the natural food of the calf is then wholly unsuited to the kitten or the infant, yet the chemist will find that the food of all three at this time contains the same basic nutritive elements as it did at birth. An important matter that seems to have been generally overlooked as far as milk is concerned is that this natural fluid is a food for a digestive tract that is rapidly changing its form and function, and the differences in the digestive properties of the milks of various species are for real and specific purposes.

As nutrition is the basis of all physical life, we see how important a function milk performs at the very beginning of existence in developing and preparing the digestive tract of each species so that it can digest and assimilate food that must nourish it in later life. We must thus emphasize the fact that milk through its protein has a *developmental* as well as a nutritive function to perform.

A directly practical point that can be deduced from this study is the importance of the mothers of every species suckling their own offspring, as they always do except in the highest species—man. The milks of different species are not readily interchangeable because the proteins have functions in helping to develop such radically different digestive

apparatuses. From a nutritional standpoint milks do not differ very markedly, but in developmental quality they are far apart. This forms a very good additional reason why every human mother should, if possible, nurse her own infant. The higher mortality following artificial feeding is thus not the only reason in favor of maternal nursing. In the former case by using the milk of another species—the cow—we put a hard curding milk into a stomach intended and adapted for a soft, flocculent curd. This is not only the cause of much indigestion, but such substitution fails to adequately carry out one of the functions that milk was intended to perform in the scheme of evolution,—namely, in each species to specially develop certain parts of the gastro-intestinal tract that must later perform most of the work of digestion.

PROFESSIONAL CONTRIBUTIONS TO INVALIDISM

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> "The world's no blot for us,
> Nor blank; it means intensely and means good.
> To find its meaning is my meat and drink."

INVALIDISM: The habit of discussing our ills is apparently inveterate. The topic is as perennial as the weather and one which inspires eloquence even in the tongue-tied, and it is part of the shame of our intelligent (?) civilization that the frequency of invalidism is such that no babe waxes into short clothes without learning the chant of the invalid. There is no neighborhood, and indeed few homes, but count among their number sufferers from disease. To the eyes of advanced science much of this must be classed among the useless miseries of existence. Our own ignorant neglect of the laws of nature is largely responsible for the swelling chorus of suffering, misery and gnashing of teeth; and far too many of these unfortunates resent any imputation of personal responsibility, but spend much argumentative energy in settling to their satisfaction the entire blame upon their ancestors. It is not improbable that our descendants likewise will have many nice things to say of us.

The accuracies of modern medicine are filching from the quiver of disease dart after dart of potent damage and rapidly indeed are the causes of the grosser forms of invalidism being relegated to homes of crass ignorance or lives of senseless indulgence. Each decade, however, the standards of civilization are placed higher and the efforts requisite to keep in the van become increasingly strenuous. Meanwhile, the numbers able to join in the advancing ranks are increased. As man slips the bridle into the mouth of one after another of the forces of nature and by a finger's touch is able to turn midnight into noon, to set ten thousand wheels in motion, to contract the miles into inches and rend continents asunder; the mental strain increases in ratio to the decrease of physical work, and disuse of the body all too frequently permits misuse of the mind.

We will not question that a goodly proportion of the world's invalidism is an unavoidable by-product of the world's work, and that frail minds and bodies will ever strew the wayside of progress. Pitiful indeed is the necessity, yet a price each heroic soul will gladly give for the advancement of his race. In this discussion, however, we are particularly interested in the equally large class whose invalidism is use-

less and is but economic and spiritual waste. Our wider knowledge proves with pitiless conclusiveness that much of the suffering of the present time is the result of man's meddling with nature. The victories of science have made it clear that matter is but the plaything of thought, and the expert assures us that much of man's endless tale of woes, so eloquently described by thoughtless tongues is but a jangling discord of weakness and pain, produced by the careless or ignorant performer. In all too many homes the spirit of invalidism is a household goddess at whose shrine each member of the family does devotion. Even as in the days of our Lord, many a poor soul is held in bondage by this spirit of infirmity eighteen years, yea, twice eighteen years, waiting to be loosed by some Lord of the Miracle. Meanwhile, the daily routine, the household activities, the best time and strength of one or more helpers, the interest and devotion and earnings of the strong members of the family, must rise in incense from the altar of sacrifice. In our fair land alone, the productiveness of tens of thousands of homes is being dissipated through the tyranny of what by half knowledge is considered one of life's inevitables. When the touch of larger knowledge turns on the full light of truth, the irreligion of this self-torture of ignorance will be apparent, and all of the vanity of this form of invalidism fade away. I recognize how vast a field of romanticism and sentimentality will be devastated when we all understand and rightly value the various forms of invalidism and refuse to humor, aye to tolerate that parasitic mass of the self-pitying, self-centered, sympathy-craving, wilful, indulged, satisfied and unnecessary invalids. A glad day indeed will it be for the noble burden-bearers when disseminated knowledge rids home and community of the vitality-reducing oppression of what many to-day look upon with awe as sanctified and solemn suffering. For those inevitable invalids whom we shall always have with us, sympathy and charity and love and service will ever be their spontaneous mead. But for that invalidism which does not belong to this hopeless class; the invalidism of convenience, selfishness and ignorance, that passive, inert and vulgar mass which is to-day robbing pity, defrauding love and paralyzing charity; every word of knowledge, every ray of the white light of truth, every effort to repress, are God-sent messengers of redemption.

Who can count the cost of the world's invalidism? Some try to cheapen it by expressing it in so many millions per annum. This represents but the smallest expenditure. This weird by-path of life is strewn with some of the richest of man's gifts. Energy lies fainting, ambition is crippled, weak and dying, the purse of generosity is emptied, sympathy has wept her eyes blind, the heart of love has burst, even truth babbles and unselfishness has long since been crowded from the by-way by the glutton of self, who has robbed all his ministers of

their virtues, himself remaining virtueless. Close following with shambling foot-steps, eager to complete the toll of suffering, follows idleness, the poison-breeder, contaminating the very air of heaven, and how may the moral life survive in his baneful presence? The cost of useless suffering can never be told by the scales of the money-changer, but it is to be known by the wrecked lives, the deadened hearts and the defective characters it has produced.

The Professions.—To one man in a hundred is given the desire, the will or the ability to lay hold on the higher truths of life and to raise himself through special preparation and contemplation above the standard of general averages in special lines of knowledge. These men usually belong to one of the so-called professions. A profession is an occupation which properly involves a liberal education. Before entering into the more restricted walk of his specialized learning, he devotes years to the development of all his mental faculties in a comprehensive study of mathematics, science, language and the arts. No professional man is worthy the name who has not received such preparation. Rich endowments and great centers of learning are at his service, and for a pittance the door of the accumulated knowledge of the ages is opened to him. He is above all other students expected to master the underlying principles of all the branches of learning he assays. Reason and judgment, comparative ability, the critical sense and recognition of the truth under all guises should be inherent in the developed professional man. Whether lawyer, minister, physician or artist, his determining ambition should be to seek and find and proclaim the truth. Though this ideal is rarely attained in the individual, the influence of the professions in matters of opinion is more often justified than mistaken. The very livelihood of the majority of professional men grows out of the confidence of the public in their knowledge and wisdom, a confidence which must largely be justified by results if one is to be accounted successful. Based upon his preparation, his ability and the confidence of his fellowmen, he maintains an enviable leadership and sways a potent influence over the opinions of his neighbor, who trusts his lands and his fortune, his health and physical comfort, his happiness here and hereafter, yea, his very soul's life, in the hands of his professional adviser. Upon a class accepting such sacred trusts rests a relentless responsibility and every word and act is fraught with peculiar influence, while the customs and habits of the professional man are often models which his less learned brother blindly follows to his weal or woe. Does it not behoove these leaders of thought, action, habit and opinion to attain wisdom with their learning and not be content with minds cluttered with mere knowledge?

As our knowledge increases in accuracy, we find that few laws are more simple than those of keeping well, we realize that the maintenance

of health can be condensed into a few simple precepts which the child or the ignorant may understand. But the living of these simple laws demands daily exercise of will and sacrifice of personal ease, a turning away from tempting indulgences and an active expenditure of effort and consistent denial of desire. The average man rebels at the rigid exaction of these plain laws of health and all too often endeavors to out-argue nature, to reverse her decrees. With the strength and subtilty of his intellect he endeavors to create for human flesh different laws than apply to all other animal kind. The practical ignorance of the educated of the simple laws governing physical well-being is appalling, while very few indeed are found who, with any sort of consistency, accept and live those mental and moral laws which stand for perfection of health. Thus it results that robustness is rather the exception than the rule in the lives and homes of professional men and women. Physical frailty has indeed been so common in the past in the families of those of the higher walks of life that the ignorant were prone to consider delicacy or physical inefficiency as indicating a certain mark of aristocracy, and many a poor man's girl, finding her model in the minister's flat-chested, lily-skinned daughter, has abandoned household duties to her slaving, admiring mother to ape her sickly model. The table of the successful professional man too often groans with the burden of rich palate-stimulating, toxin-producing foods, and he and his family over-fed and under-exercised, over-clothed and under-sweated, are the first to fall victims to the common infections, tuberculosis, early Bright's disease and paralysis, while from such homes are recruited large numbers of the useless nervous invalid. How often, in the presence of doctors of divinity and legal lights of a more than local reputation, do I wish to turn away from a polluted breath, the shameful evidence of self-indulgence or ignorance in high places. Daily the physician is called to those homes of supposed refinement and learning to allay suffering, to quiet tortured nerves, to stay disease's ravages, to witness the last breath, where untimely death has ended useful careers because in these homes of so-called wisdom and leadership the crudest ignorance of the simple, rational formulæ of physical life has been the blight and the devastator.

The failure of the classical education to practically prepare men to live wisely has all too often been demonstrated. Classical education knows nothing of simple sanitation, of food values, of the equation between food and waste, of the nerves and their enemies. It has failed to recognize the inalterable relation between the eaten bread and the sweating brow; it has failed to instruct its students in the use of their hands, and in many of life's most productive work-shops the classical student is but a drone, so awkward and helpless and useless are his muscles. Even in youth he has grown old, because he has not learned the art of playing.

But long as is the list of physical debility and suffering, it is fully equalled by the miserable list of the mind's tormentors, chief of which are fear, that child of half-knowledge, and its half-sister, worry. I have found in many a professional man's home, the curse of fear gripping and damaging the lives of its members, and soul suffering being instilled into its children. Fear is a great producer of useless nervous torture, and yet is daily used as an influence in thousands of our best homes. Fear of the dark fills the night with terrors to the fear-taught child; fear of minor injuries and the incidental damage of knocks, bruises and falls, makes tense unnumbered mothers' lives during their children's play hours. Fear erects a barrier between youth and wholesome physical pain and makes weaklings of children and potential invalids of adults. Fear of its parents robs many a child of that wholesome admonition and counsel which he would otherwise seek, and perchance be saved from habits which sap strength of body and soul. An unwholesome fear of God and the unseen has produced untold psychic damage in unnumbered homes where such a heathenish conception of religion has robbed their children of the peace and courage which come from a religion of faith and health.

Emanating from these self-same homes come many of the fulsome testimonies of the efficiency of the products of ignorance and quackery, and many religious weeklies have been dishonored by the mass of patent-medicine testimonials appearing therein, often over the signatures of cured members of the family. Letters without number from well-known ministers, lawyers, authors and actors have made possible the irreparable mass of damage to mind and body, growing out of a dependence upon proprietary remedies, carrying large percentages of alcohol, opium, coca, chloral, bromides and the heart-paralyzing coal-tar products, usually masquerading under fictitious and misleading names. Cancer, tuberculosis and diabetic cure companies have been able to conduct their nefarious traffic in human life through the faith and trust inspired by the noted professional names and beaming intelligent faces used as testimonials. Grave responsibilities have certainly been assumed with a carelessness or ignorance of the awful consequences, to the shame of many thousands of professional men. So much of the sickness in the homes of the educated is of a psychic or nervous type, influencing individuals in whom the central nervous system has been long over-stimulated and in whom the reaction of mind upon body and body upon mind have become increasingly sensitive, individuals in whom, as in the delicate chronometer, misadjustments are easy and whose ever-sensitiveness acts as a magnifying glass, exaggerating the apparent seriousness of all their suffering; individuals in whom attention and memory pains may be produced almost at will, pains which the family practitioner fails to analyze or understand, and which finally

increase to the sufferer's apparent undoing, yet capable of disappearing at any time as if by magic, under the potent influence of an absorbing miracle of health production. And here again we find many of our professional leaders turning away from the definite accuracies of the natural sciences and allying themselves with the cults and isms of mystic fame. I would not for a moment question the wisdom of being tricked into health if it can be obtained no other way. I am arraigning that gross ignorance in the educated, which makes possible this class of illness and allows leaders to multiply the growing harm which comes from unscientific, non-treatment of disease of mechanical and chemical origin, through the force of their harmful, misleading example. The above characteristics may be recounted more convincingly if we will consider some concrete examples of professional contributions to invalidism.

The standard novel of our boyhood reading painted a most pitiful picture of its average heroine from the standpoint of health—slender in waist, slight in figure, fair to faintness, languid, dainty and delicate, all too good for this world. Out of this conception of aristocratic feminity how many thousands of our women have half-starved themselves, living on pickles and vinegar and lacing their protesting waists until their internal organs must have been addled, have systematically protected themselves from God's out-of-doors and health giving sunshine and made themselves anemic, flat-chested, flabby-muscled, toxic, disease inviting, parasitic playthings! Even the more wholesome athletic heroine of the modern novel has not yet succeeded in driving from our midst these inane products of professional making. In far too many of the homes of influence to-day weakness is coddled and perpetuated because it still wears the halo of romantic beauty.

We look to the artist as the source of our ideals in adornment. I doubt not that the true artist would resent any association with the production of much that is styled beautiful in the decoration of our persons, and yet the artist is exceptional to-day who does not add the influence of his drawings to many of the health damaging and comfort destroying arrayments of the passing style. The physical damage to health as manifested in the annual thousands of unnecessary pneumonias in the fur-coated, silk-stockinged, bepumped apers of style, is not to be compared with the moral damage growing out of the insistent emphasis on the exaggeration of some of the female sexual characteristics, which are never lacking in the popular French creations. One season the bust is emphasized, another the hips, again the skirt is fairly stretched to reveal the thighs or so hobbled that silk stockings must be worn in self-defence. Unfortunately, even some of our prominent artists have repeatedly prostituted their art in propagating and popularizing styles in which our wives and daughters innocently bedeck

themselves in most suggestive attire, little realizing that the débutante's slouch of to-day is but a reproduction of the baudy house negligée of yesterday.

The contributions of the legal fraternity to the useless waste of suffering too often illustrate the lack of the judicial mind or the domination of the mercenary spirit. The competent, painstaking, conscientious physician is rarely called by the attorneys of the prosecution in personal injury suits. His opinion might be too near the truth for practical use; for medico-legal records are crowded with examples of invalidism based entirely upon the suggestive influence of a certain type of lawyer, a hypnotic invalidism which is genuine from the patient's standpoint. Through the representations of poor hysterics created by the influence of interested attorneys, corporations are filched many thousands annually by the combination of ignorance and cupidity. Accurate psycho-analysis reveals unerringly the ideational basis of many of the paralyses, spinal injuries and nervous prostrations following accidents, and producing uncompensated waste of time, loss of will and unconscious deception, yet all the outgrowth of the suggested idea. We know a type of lawyer too intelligent and honest to be *particeps criminis* in such fraud. I realize that the testimony of one or more physicians is usually necessary to the attorney in making his case in these trials, but I firmly believe that in the majority of instances the physicians engaged are unprepared to make those fine distinctions which are necessary in discriminating the functional from the organic disturbances of the central nervous system. The large number of spontaneous recoveries following the termination of these suits, favorable or otherwise, is opening the eyes of thoughtful physicians to this shrewd exploiting of medical ignorance by a sister profession.

It is with hesitation and a large degree of respect and awe that I invade the sanctity of the pastor's study. The art of the physician has long been devoted to healing the body. The minister has been the physician of the soul. With the great modern increase of psychic disorders, doctor and minister have each been appealed to for help. The intellect has been called the bridge spanning the chasm between the spiritual and the material worlds, and it is but natural that we should find the doctor of the soul at one approach eager to assist and support the weakened travelers of life. Meanwhile, the problem of attendance has emphasized the church's relations to man's physical life, while the providential idea of disease still holds a large proportion of church people in its fatalistic grip. Thus the minister ever finds himself intimately associated with human illness and suffering. Owing to the Bible's comprehensiveness, the devotee can extract from Holy Writ a most pessimistic religion of fear, and many a minister thus infected plants the disease of terror in the hearts of his hearers, and curdles

their faith with his fore-ordained damnations. With equal facility, another sees in the Good Book only faith, hope and love and but touches the mountain tops in his soaring optimism. So extreme may he be that he might easily obstruct the careful and painstaking work of our scientific health boards by his insistence on Divine protection, even in the midst of filth, flies and infection. And such contributions to invalidism are not overdrawn. Ofttimes the insistence of the religious teacher on the *minutiæ* of over-conscientious scrupulosity turns the eyes of the susceptible individual inward and produces that miserable disease of self-contemplation and paralyzes unselfish, productive effort by the obsession to be always right. One of the most difficult of the minister's problems is placing the proper emphasis upon the essentials and non-essentials in human conduct. The great art of harmonizing with one's environment is often unknown to the minister himself, and his efforts to inculcate help in this essential of leadership are therefore hopeless. The righteousness of deliberate damage to the body through the self-punishment of extreme asceticism has largely disappeared as an influence emanating from our modern church teachers. Yet the student of humanity still sees in the limitation of proper emphasis in church teaching of wholesome physical and mental living and the over-emphasis by so many religious leaders of the thought that nothing matters but the soul, an emphasis which fails to recognize man's composite nature, an emphasis which if carried to a logical conclusion would result in a rapid reduction in human life, therefore in the production of souls. In this unwise emphasis may still be found remnants of old ascetic ideas. Religious susceptibility ofttimes results in the development of mere religiosity with no basis of character strength. The moral will is most naturally trained through the development of physical stability and mental determination. Some morbid teachers find in suffering and sorrow and misery the only possible road for the development of high moral character. While not for a moment discounting the importance of suffering and misfortune in the development of religious character, when properly received, it still remains true that the majority of unfortunates have failed to extract blessing from misery, while the healthy body and well-poised mind will ever remain the most fertile soil for soul growth. Many a poor mortal has lost his chance to lay hold on his foundation for soul health through very religious but ungodly advice that he work out his salvation in prayer and fasting, when his whole nature was dying for want of a religion productive of utilitarian activity. Sentiment is a delicate dessert, but in the feast of life the courses that sustain and make the brawn and sinew of mind, body and soul are found in life's rough and tumble, in which alone the preacher, teacher and doctor may find moral wills for religious invalids. To all leaders of the weak come frequent heart-moving

appeals from the slaves of sense. Often it is the cry of a soul which seems to be staggering under the hand of fate, one of that increasingly large number, a child all too often of one of our old families, who has felt the hot breath and burning desire for artificial drug comfort or stimulation. At the risk of my appeal being dismissed by many as that of a fault-finding abstainer, I feel impelled to express my peculiar burden of responsibility in regard to this pitiable class of weak and often defenceless fellow-men. At every corner the world flaunts her lurid temptations; at all too many social gatherings the mocker is bedecked in dazzling cut glass and iced into seductive coolness, one draft of which means defeat, for a taste opens the flood gates of hell in these sensitively organized weaker brothers. No tempted men and women fight more earnestly than many victims of drugs and alcohol. Little help can they receive through the wisest medical care, still doctor and friends and teacher unite in giving the trite advice to "cut it out." "Touch not, taste not, handle not" has been the sum of human wisdom in their behalf for multiplied centuries. The religious adviser shakes his head and assures the defective that the grace of God is the only power which can save him. He is pressed to attend prayer-meeting and church services, and there thoughtlessly kicked hellward with fermented communion wine. Many a poor soul has lost his fight at the "Lord's table." Usually of attractive social qualities, society welcomes him to her feasts when he is straight, then looks at him with obvious disdain when he tremblingly turns down his wine glass. At the annual medical or legal banquet, surely no power but the grace of God can save him in the midst of spiked punch, cock-tails, the cool, freely quaffed amber beer, the laughing dancing golden champagne, the personally conducted high-balls of the cloak room and the formal course wines of the supper, vying with each other as his soul's seducers. We are cataloguing professional contributions to one of the most soul-damning forms of invalidism known to unstable man. Faith in forms, customs, ceremonials, rights, alone is but husks. Faith, the reason of the heart, must be based on the truth of accurate knowledge, which is the reason of the mind.

I have reserved my own profession until the last in considering the damaging influences growing out of the defective example and teaching of mankind's logical leaders. Last, because from the very fact that they are by profession healers, their shortcomings are more reprehensible and far-reaching and damaging in their effects. It is a great misfortune that the difficult curriculum of modern medical colleges is so burdened with the complexities of disease, its causes, symptoms and treatment, that little or no room has been left to teach normal living. The doctor's medical rearing takes place in an atmosphere saturated with disease and the complexities of its treatment, and it is only in the latest years that any attention has been given to teaching him how disease can be pre-

vented, and little or no instruction is yet given along the lines of the simple, rational physical and thought life which counts so emphatically for health. A second and graver defect in the physician's education lies in the fact that many complete medical courses are planned and carried out with no reference made or even suggestion offered to the student of man's mental, physical and spiritual interdependence. The young physician must grope about through several foggy years before he accidentally learns the newer psychology or has this fundamental relationship knocked into his understanding by the plain logic of experience, and realizes that many invalid-producing misadjustments are due to other than physical causes. This defect in the average physician's education accounts for the long list of invalids suffering as a result of psychic or moral trauma, which he drugs in vain. The common medical insistence on materialism must give place to a broader conception of man's being. The story of medical mal-leadership of the past is a shameful one; based as it is, however, largely on ignorance and often upon honest ignorance, it must in a measure be excused. To-day many souls are giving their all, in rare nobility that the problems underlying human ills may be solved. Still medical leadership shows numbers of common and very damaging defects of influence. The average physician's slavery to drug medication is difficult for intelligent minds to understand. It is too closely associated with the methods of dishonest quackery to be comfortable under scrutiny. The majority of medical prescriptions call for compounds absolutely lacking in specific or even general influence upon disease processes, and yet how rare is the physician who after examining the patient, and realizing that drugs can be but a false help, frankly gives his patient truly helpful advice, advice properly influencing his personal habits, which will, if followed, produce real cure. Many physicians satisfy their patients' almost superstitious desire for medicine and their own knowledge that there is no drug to cure, by administering what is technically termed a placebo, a harmless inert substance which contents the sufferer until nature accomplishes that which the physician is unable to helpfully modify by pill or potion. How seldom the physician takes his patient into his confidence and explains the *modus operandi* of such treatment. So the fetish of drug dependence, strong in the physician, lays an even heavier hold on the laity. This would prove of but comparative damage if all medicine were innocent placebos, but in his armamentarium, the physician has medicaments of a potency irresistible for good, but likewise fatal for damage, drugs which for the time will stay the trembling hand and whip the faltering nerves into activity, which will still the small voice of discomfort, rob weariness of its weakness and lull pain and anguish into drowse and dreams. Weak and ignorant human nature clutches at these artificial comforts, little realizing or caring that too often the fire of

disorder has but temporarily been chocked with new fuel, to soon break out the fiercer. How few physicians frankly and firmly show their patients the common relation between drug taking and character weakness? How often do they make clear to impatient sufferers that the help given by drugs is but fleeting and that too often dodging the corners of discomfort is the first step toward the death of will? How rarely is the physician's influence strong and wholesome in inspiring the patient with his superiority to circumstances! How seldom does he quietly and hopefully explain the nature of the disorder and its rational, logical handling without habit-producing or will-wilting poison, and show him how he may by passing through a few hours of temporary discomfort learn that profound lesson of will and health which will be his future protection! The contributions of medical weaklings to the great aggregate of damage caused by unwise drugging, are mentioned with shame. As a profession, doctors, in addition to harmful drug use, fail in their higher usefulness through a willingness to nurse and coddle unnecessary suffering, and through many popular, though questionable arts of superficial sympathy, not only maintain but produce invalidism. So much of the waste of sickness of to-day grows out of self-indulgence that it is humiliating to see our men of medicine pampering the weaknesses underlying these human derelicts. It is truly a serious charge to make against one's own profession, that in the practise of its art, it is aiding and abetting the very invalidism which looks to it alone for cure. Could every doctor fill his patients with some measure of manly contempt for comfort, safety and ease, and inspire each of his ill ones with a larger and nobler conception of the blessing of transient suffering manfully faced, as compared with the misery of self-pity which comes when a human being surrenders all that stands for personal victory and self-mastery to a craven hour of ease, then would the days of much useless invalidism be numbered. Meanwhile, the stronger, wiser and truer of the medical profession will be found working shoulder to shoulder with all teachers of wisdom in that noble and stimulating task of supplying wills for the will-less.

I wish my subject permitted even a few paragraphs on the brighter and more inspiring aspect of sickness, that I might give a physician's testimony to some of the wholesome lessons of illness, of the growth of character in the midst of pain and infirmity and disability, how deformity is often associated with an inspiring sweetness of spirit and how joy and strength and happiness dwell in the shadows of death, so I might tell of the power of the hand fairly transparent in its weakness to clutch the heart of friends and helpers with a grip that steels the strong to greater strength and stays weakness in its wastefulness. It would indeed be joy to write thus. But I may drop but this hint of the silver lining of the cloud which has occupied our attention for the hour.

My final appeal is for the development of a class of guides, call them doctors, ministers or teachers, or what you will, so trained in the understanding of a man's physical, mental and moral needs as to know the individual in all his phases, so equipped with the ability which follows a complete mastery of his profession and so filled with that irresistible power which comes when one has joined understanding with truth, so imbued with sympathies alive to human nature and its changing needs and so supported by all true helpers of mankind that his word will stand as authority and his wisdom prevail in levelling the heaped up monuments of invalidism, which to-day are being built through the ignorance of professional leadership.

> "The world's no blot for us,
> Nor blank; it means intensely and means good.
> To find its meaning is my meat and drink."

IS SELECTION OR MUTATION THE MORE IMPORTANT AGENCY IN EVOLUTION?

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THIRTY years ago the opinion prevailed among biologists that biological evolution, like geological, is a very gradual process in which agencies acting with uniformity over long periods of time gradually produce changes in existing species through natural selection. About the year 1900 a change of opinion set in, which may be described as a tendency to return to the older idea of the sudden and special creation of species. Not that the idea of evolution was to be abandoned, but the province of natural selection was now thought to be less extensive, its action being limited to deciding what species shall survive. As to the *origin* of species, this was supposed to occur suddenly as a result of undetermined agencies, but not to be either attended by natural selection or caused by it. This theory of the sudden and spontaneous origin of species unattended by natural selection is known as the mutation theory. Philosophically it has much in common with those geological theories which regard geological epochs as inaugurated by terrestrial catastrophes, and those astronomical theories which involve cosmic collisions and explosions in the origin of new heavenly bodies. Historically the mutation theory owes its present popularity chiefly to the work of the Dutch botanist, DeVries, and the Danish botanist, Johannsen, though many others have given it ardent and valuable support.

In clearing the ground for a theory that species are not produced by natural selection, DeVries and Johannsen have attempted first to show the inability of selection of any sort to produce specific changes. Selection, they maintain, can produce nothing new. It can only sort over and rearrange variations already present. The strongest existing evidence in favor of this view consists of the selection experiments of Johannsen with size variations in beans and the similar experiments of Jennings with paramecium. As a result of this and other similar work a useful classification of variations has been established, which are said to be either *phenotypic* or *genotypic*. The former are variations due to purely environmental causes, such as soil, temperature, humidity, food, etc. These are not inherited. They are apparent rather than real racial changes so far as evolution is concerned. In contrast to these phenotypic variations are those called genotypic, the causes of which lie in changes within the germinal substance. They are hereditary.

Environmental agencies, those which produce phenotypic variation, are very complex and oftentimes one agency counteracts another. The

resultant or combined action of several independent agencies is in biology as elsewhere, to produce variation of the frequency-of-error sort. This kind of variation which mathematicians express in the so-called "normal" curve or "curve-of-error" biologists call "continuous" because it consists of graded quantitative variations which shade insensibly into each other.

The best known cases of genotypic or heritable variations are those which are of considerable magnitude and in which a single genetic factor is involved, because it is easier to follow the history of these from generation to generation. It was therefore a natural but none the less unfortunate conclusion on the part of the mutationists that *all* continuous or graded variations are phenotypic (not inherited), while all genetic (heriditary) variations are discontinuous. Manifestly this is a pure assumption, for logically it is to be expected that several independent genetic agencies acting simultaneously will produce continuous variation, whereas a single and isolated environmental change may produce discontinuous variation. In fact, Mendelian studies have already shown that several independent genetic factors may frequently produce a series of graded or continuous variations. But if these supposed factors are themselves constant, it is theoretically possible to alter the racial type by selection only to a limited extent. For the action of selection will be restricted to the production of the possible combinations or permutations of the genetic factors present. But if, on the other hand, genetic factors are themselves variable in a quantitative way, continuous or graded variation of the organism might result from the action of one genetic factor alone, and all the more from the joint action of several such varying factors. In that case selection would be capable of producing uninterrupted change in racial characters, because it could not only isolate particular combinations of genetic factors, but it could also isolate higher or lower quantitative stages of each factor. Its action would therefore be limited only by the limits of variability of each genetic factor.

Mendelians have generally assumed that the genetic factors with which they are concerned are quantitatively invariable. This assumption was made, probably at first, for logical simplicity and then from habit, so that now it has come to be one of the fundamental tenets of many Mendelians. But so far as evidence is concerned, either observational or experimental, it has small basis. At first Mendelians assumed that all *characters* which Mendelize are invariable, that crossing does not affect a Mendelian character, that the recessive character when it is recovered again following a cross is the same as ever and so Bateson proposed in 1902 to discard old ideas of racial purity and institute a new test of racial purity which should consist simply in determining the presence or absence of particular Mendelian characters. But more careful study of Mendelian characters soon showed that they were not

invariable. Extracted recessives were frequently observed to be different from the recessives which entered into a cross two generations previously. So the idea of character constancy had to be abandoned, but in its place has come the idea of *factor* constancy. It is now held by many that the changes observed in Mendelian characters as a result of crossing are due to other independent genetic factors introduced by the cross, the main factors themselves being unaffected. If this is so, then by eliminating these *other* or modifying factors it should be possible to secure an invariable or pure race. Such pure races it was believed by Johannsen that he had secured in the case of self-fertilized beans studied by him, and Jennings at one time entertained similar views concerning asexually produced races of paramecium. But it should be pointed out that in neither case was a Mendelian character under observation, so that these investigations have no direct bearing on the question whether Mendelian factors are or are not quantitatively variable.

In my studies of Mendelian heredity I early encountered characters obviously variable and I have been engaged for several years in trying to discover the causes of this variability. Crossing was evidently such a cause, contrary to the earlier idea of character constancy and gametic purity. This having been settled, attention was next directed to the theory of factor constancy. To test this, crossing must obviously be avoided, since by this means the experimenter might unwittingly introduce modifying factors. Modifying factors must either be eliminated or rendered constant before one could hope to test the variability or invariability of a single factor. The surest means to this end would be inbreeding attended by selection. Under this procedure modifying factors should be gradually eliminated or rendered constant (homozygous) and a condition of racial stability secured equal to the stability of the single genetic factor concerned in producing the character under observation.

If the genetic factor in question were entirely stable and invariable, racial change under selection should gradually slow up and finally stop altogether, as one modifying factor after another was eliminated or rendered constant (homozygous), and this is what DeVries and Johannsen have assumed actually occurs.

The best material which I have been able to discover on which to test this matter consisted of piebald black-and-white or gray-and-white hooded rats. This color pattern of white and pigmented areas behaves in heredity as a simple Mendelian recessive character. (See Fig. 1). It is the alternative (or allelomorph) of the entirely pigmented or "self" condition of wild rats. In crosses with such wild rats the hooded character is recovered as an extracted recessive character in one fourth of the second generation offspring. In a total of 1,483 such offspring, 493, or 24.9 per cent., have been hooded. Individuals possessing the recovered

character frequently have either more or less extensively pigmented bodies than their hooded grandparent and are not entirely uniform among themselves. In fact a family of hooded rats is never entirely uniform, no matter how closely selected and inbred. They produce only hooded young when mated with each other, but some possess rela-

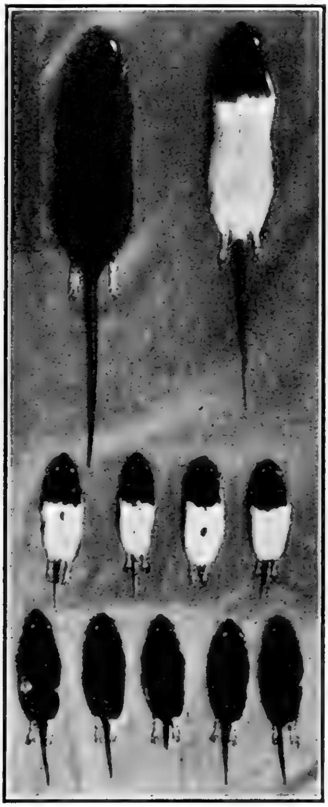


FIG. 1. SKINS OF A LITTER OF NINE RATS AND OF THEIR PARENTS. The inheritance is alternative (Mendelian) but each alternative condition shows slight quantitative variations.

tively more white than others. In order to learn whether these quantitative differences in the hooded character are hereditary, selection experiments were begun in 1907 upon a small colony of hooded rats derived originally from less than a dozen individuals. The blackest rats (*i. e.,* those with most extensive black areas) were chosen to start a plus selection series, and the whitest rats (*i. e.,* those with least extensive black areas) were chosen to start a minus selection series. From the offspring of the plus selected parents the blackest were again chosen, and from the offspring of the minus selected parents the whitest were chosen, and this process was repeated in each generation. Sixteen successive selections have thus far been made in the plus series,

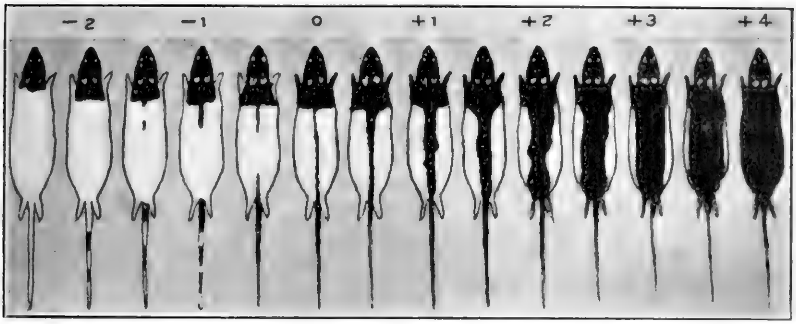


FIG. 2. A SCALE OF ARBITRARY GRADES USED IN CLASSIFYING THE FLUCTUATING VARIATIONS OF HOODED RATS.

and seventeen in the minus series. The plus series has become steadily darker, the minus series lighter, until two very distinct races have resulted. In order to classify the young more accurately and to express in more definite terms the quantitative changes which have taken place in the hooded character, each rat has been graded in terms of an arbitrary scale of increased (plus) or decreased (minus) pigmentation as compared with the original modal condition of the race (zero condition). See Fig. 2.

TABLE I

RESULTS OF THE PLUS SELECTION OF HOODED RATS CONTINUED THROUGH SIXTEEN SUCCESSIVE GENERATIONS

Generation	Mean Grade of Parents	Mean Grade of Offspring	Lowest Grade of Offspring	Highest Grade of Offspring	Standard Deviation of Offspring	Number of Offspring
1	2.51	2.05	+1.00	+3.00	.54	150
2	2.52	1.92	−1.00	+3.75	.73	471
3	2.73	2.51	+ .75	+4.00	.53	341
4	3.09	2.73	+ .75	+3.75	.47	444
5	3.33	2.90	+ .75	+4.25	.50	610
6	3.52	3.11	+1.50	+4.50	.49	861
7	3.56	3.20	+1.50	+4.75	.55	1,077
8	3.75	3.48	+1.75	+4.50	.44	1,408
9	3.78	3.54	+1.75	+4.50	.35	1,322
10	3.88	3.73	+2.25	+5.00	.36	776
11	3.98	3.78	+2.75	+5.00	.29	697
12	4.10	3.92	+2.25	+5.25	.31	682
13	4.13	3.94	+2.75	+5.25	.34	529
14	4.14	4.01	+2.75	+5.50	.34	1,359
15	4.38	4.07	+2.50	+5.50	.29	3,690
16	4.45	4.13	+3.25	+5.87	.29	1,690
						16,107

The first plus selected parents were of mean grade + 2.51. They produced 150 young of somewhat lower average grade than their parents, viz., + 2.05 (see Table I.). A second selection gave a similar result, but with young of slightly lower mean grade, viz., + 1.92. With each subsequent selection it was possible to raise the standard of the selected parents, and in each case the grade of the offspring has in-

creased correspondingly. As a result of the sixteenth selection, 1,690 young have been obtained *every one of which is darker* than *any* hooded rat born in the series previous to the second selection. Accordingly the character of the entire race has changed under selection. This change has come about gradually. Generation by generation, as the mean grade of the parents has advanced, that of the offspring has advanced in like measure, but always lagging behind the grade of the parents. With advance in the *mean* grade of the offspring has gone advance in both the upper and the lower limits of their variation. The amount of variability of each generation of offspring as measured by its standard deviation has decreased to about three fifths of its original extent, but has not changed materially in the last eight or ten generations, and there is no prospect of its declining further. The rate of racial change has also not become less. Reversed selection returns the race toward its previous condition at about the same rate as the departure has taken place.

It seems clear from these observations that the hooded character, though itself a simple Mendelian unit in heredity, is subject constantly to slight quantitative variations which are themselves to some extent hereditary. These quantitative variations are grouped like continuous variations round a mean the position of which may be altered gradually but permanently by repeated selection.

A series of seventeen minus selections yielded results similar to those obtained in the plus selection series, but with a movement of the mean and of the upper and lower limits of variation in the opposite direction (see Table II.). In this case a race has been secured whiter in nearly every individual than any rats contained within the original race. The whitest rats have only a few pigmented spots left on the body, chiefly located on either side of the head close about the eyes, ears and nose. In the plus selected series the blackest rat obtained (grade + 5.87) was black all over except for the presence of a few white hairs on the chest between the front legs. No fancier would have thought of including it among "hooded" rats, or even among "Irish" (white-bellied) rats; fanciers would undoubtedly have classed it among "self" rats. There is apparently no limit to the quantitative change which can be produced in the hooded pattern by selection, short of its complete extinction in the all white or all black condition toward which our minus and plus selections respectively are steadily tending. Yet there can be no doubt that only a single genetic factor is here involved. A tentatively adopted hypothesis that modifying factors were concerned in it has been definitely disproved. Any finite number of such modifiers would have been greatly reduced or eliminated altogether by seventeen successive selections, yet no slowing up is observable in the rate of change of the racial character under selection either plus or minus. The changes effected by selection show per-

manency under crosses with wild rats. They change no more nor less than an unselected hooded race does. A first cross of the selected races seemed to show a partial undoing of the changes produced by selection, but a second cross made on a still larger scale, involving over 1,000 second generation individuals, showed no further change of this sort, but instead a return to about what the selected race would have been had no crossing at all occurred.

TABLE II

RESULTS OF THE MINUS SELECTION OF HOODED RATS CONTINUED THROUGH SEVENTEEN SUCCESSIVE GENERATIONS

Generation	Mean Grade of Parents	Mean Grade of Offspring	Lowest Grade of Offspring	Highest Grade of Offspring	Standard Deviation of Offspring	Number of Offspring
1	−1.46	−1.00	+ .25	−2.00	.51	55
2	−1.41	−1.07	+ .50	−2.00	.49	132
3	−1.56	−1.18	0	−2.00	.48	195
4	−1.69	−1.28	+ .50	−2.25	.46	329
5	−1.73	−1.41	0	−2.50	.50	701
6	−1.86	−1.56	0	−2.50	.44	1,252
7	−2.01	−1.73	0	−2.75	.35	1,680
8	−2.05	−1.80	0	−2.75	.28	1,726
9	−2.11	−1.92	− .50	−2.75	.28	1,591
10	−2.18	−2.01	−1.00	−3.25	.24	1,451
11	−2.30	−2.15	−1.00	−3.50	.35	984
12	−2.44	−2.23	−1.00	−3.50	.37	1,037
13	−2.48	−2.39	−1.75	−3.50	.34	1,006
14	−2.64	−2.48	−1.00	−3.50	.30	717
15	−2.65	−2.54	−1.75	−3.50	.29	1,438
16	−2.79	−2.63	−1.00	−4.00	.27	1,980
17	−2.86	−2.70	−1.75	−4.25	.28	868
						17,142

The conclusion seems unavoidable that the single genetic factor involved in this case has undergone quantitative change under the influence of selection. If so, two foundation postulates of the mutation theory are false, viz., (1) that continuous or graded variations are not concerned in evolution and (2) that selection of such variations, no matter how long continued, can effect no permanent or progressive racial changes. Selection, as an agency in evolution, must then be restored to the important place which it held in Darwin's estimation, an agency capable of producing continuous and progressive racial changes. Evolution biological as well as geological may still legitimately be regarded as a gradual and continuous process free from sudden catastrophes.

The idea of fixity among living things seems to be one which the human mind is loath to give up and which has to be constantly combated in the advancement of biology. For centuries it was the fixity of species which dominated biological thought. Darwin had to dispel this idea before he could get a hearing for evolution. When the Mendelian theory of unit-characters came in, the idea of fixity, unchangeableness, attached itself to the unit-characters. Driven from this hold,

it now seizes on the single factors on which Mendelian characters depend. Simultaneously it attaches itself to the conjectural mechanism which underlies Mendelian heredity, the chromosomes. We hear much now about their fixity and constancy of structure down to the minutest visible granules, and the argument is even offered that inherited characters must be constant because the chromosomes are. It is probable that, if chromosomes could be seen as readily as inherited characters, their structure would be found to be no more constant than that of the inherited characters supposed to depend upon them. As a matter of fact students of the chromosomes do observe great variability in the size, shape, density and even in the number of the chromosomes, but those who wish to believe in the fixity of such structures find convenient explanations for these observed variations in the action of killing reagents, stains, etc., just as we geneticists invoke supplementary and modifying factors when we desire to defend the idea of fixity in our hypothetical genetic factors. The biologist may well take warning from the history of his science against assuming fixity of either structure or function in living things. The search for fixity will doubtless continue to shift, as it has done heretofore, from higher to lower stages, and will not find what it is looking for until it reaches the inorganic materials which, though they are the building stones of life, are not life itself.

Certain questions will occur to the critical reader. Is the evidence for the foregoing conclusions adequate? Are the conclusions based on a sufficient number of observations, and have these observations been carefully and accurately made? I believe that all these questions may be answered in the affirmative. Seventeen generations of offspring in the minus selection series and sixteen generations in the plus selection series have been studied. The generations of plus or minus selected offspring respectively average over a thousand individuals each, the total for the entire series being 33,249 rats, all descended from less than a dozen original recessive animals whose progeny have been continuously selected in a particular direction without intercrossing between the two series since the experiment began. Of course control crosses of various sorts have been made, as with wild rats, and between the two series, but the derivatives of such crosses have been wholly excluded from the selection series here described. Certainly no such mass of material dealing with the variation in a single Mendelian character has previously been available for study. The grading has been done with the same standard set of grades constantly at hand for comparison, and it has been done mostly by one person. The series of observations has been made possible through financial assistance received from the Carnegie Institution of Washington. Dr. John C. Phillips has rendered valuable assistance in the arduous work of raising and studying the large numbers of animals involved in these experiments.

THE PROGRESS OF SCIENCE

THE CONVOCATION-WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE scientific men of the country will hold their annual meetings this year at widely separated places and with some conflict. The American Association for the Advancement of Science is responsible for the arrangement of the convocation-week meetings, having fourteen years ago transferred its own meeting from mid-summer to the Christmas holidays. At the same time it obtained from many universities and colleges an extension of the Christmas holidays or grants for leave of absence, so that the week in which New Year's day falls should be free for these meetings. The American Association arranges also for the meetings of affiliated scientific societies which may wish to meet in conjunction with it. It is not expected that all these societies will meet every year with the Association, for there are obvious advantages in the isolation of a single society or a small group concerned with related subjects, as well as in a large congress covering all the sciences and numbering its attendance by the thousands.

In order to meet the complicated conditions as well as may be, the American Association has planned a program, according to which once in four years there shall be a great convocation-week meeting representing all the natural and exact sciences, and perhaps, ultimately, also engineering, education, economics, history, philology, literature and art. Such a demonstration of the intellectual forces of the country should be a stimulus to those who join in it and an exhibition that would impress the whole country. It is proposed to hold these meetings once in four years and in succession in New York, Chicago and Washington. The first will take place in New York at the end of the year 1916, and thereafter they will be held in the four-year periods at which the national presidential elections occur. In the intervening two-year periods the meetings will also be in large scientific centers, and it is expected that most of the national scientific societies will take part. The first of these meetings was held in Philadelphia, and the next will probably be held in Boston at the end of the year 1918. In the intervening years the American Association will meet at places more remote from the large centers of scientific population, or in cities or at universities where the accommodations are more limited. The first of these meetings was in Atlanta at the end of the year 1913, and the meeting this year is at the Ohio State University, Columbus. In 1917, it will probably be in Toronto, Nashville or Pittsburgh.

At these meetings the attendance of scientific men is in the neighborhood of a thousand; at the larger meetings it may be two or three thousand, and at the four-year periods, from five to ten thousand. The vast extent of the country makes it difficult for the scientific men of the west to visit the east, and conversely, during the Christmas holidays, and summer meetings may be held in the west once in four years, the first having been held this summer in connection with the Panama-Pacific exhibition, and on the occasion of the organization of a Pacific Division of the Association.

Although the meeting of the American Association opening at Columbus, on December 27, is not one of the larger convocation-week meetings, it promises to be of more than usual interest to those who are able to be pres-

THE HARRY ELKINS WIDENER MEMORIAL BUILDING.

ent, as was the case with the meeting held at the Ohio State University some fifteen years ago. The address of the retiring president, Dr. Charles W. Eliot, who, called from a chair of chemistry to the presidency of Harvard University, has become by common consent our leader in education, is on "The Fruits, Prospects and Lessons of Recent Biological Science." An introductory address will be made by the incoming president, Dr. W. W. Campbell, the distinguished director of the Lick Observatory. Among the vice-presidential addresses before the eleven sections of the association may be noted important subjects, treated by Professor White, of Vassar College, in mathematics; Professor Zeleny, of Yale University, in physics; Professor Lillie, of the University of Chicago, in zoology; Professor Pearce, of the University of Pennsylvania, in pathology, Professor Hanus, of Harvard University, in education, and Dr. Bailey, formerly director of the Cornell Agricultural College, in agriculture.

Eighteen national societies, including the American Society of Naturalists, and the societies devoted to mathematics, physics, zoology, entomology and botany meet at Columbus in affiliation with the American Association. The chemists do not hold a winter meeting this year. The physiologists and pharmacologists meet in Boston; the anatomists in New Haven; the psychologists in Chicago; the philosophers in Philadelphia; the geologists, paleontologists, geographers, anthropologists, sociologists and economists in Washington.

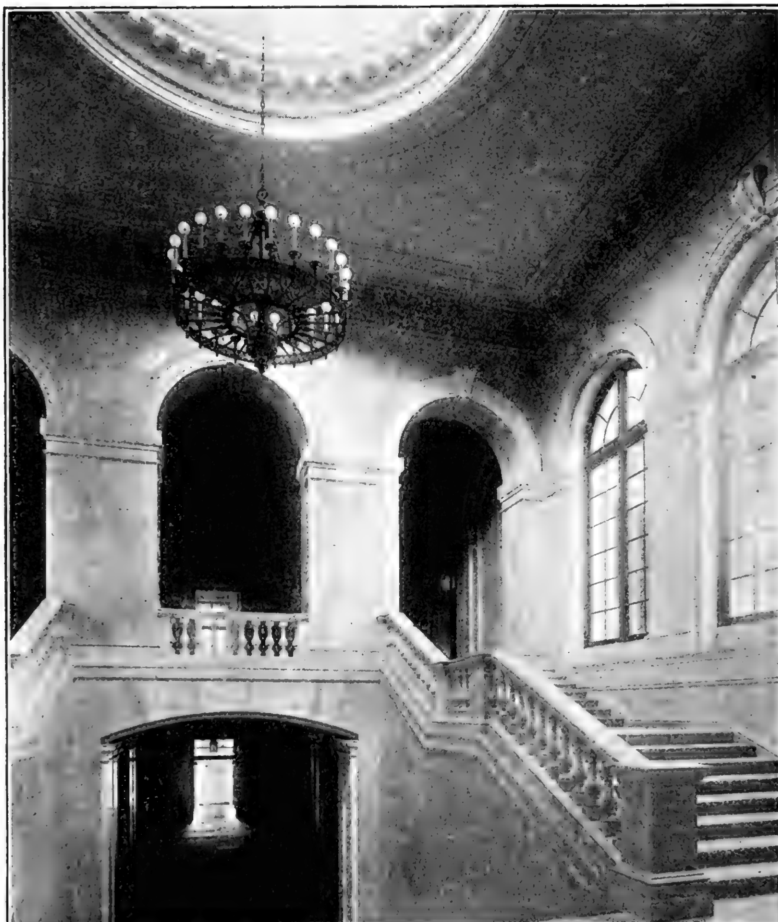
The serious conflict of the year is with the Second Pan-American Scientific Congress meeting in Washington from December 27 to January 8. It was originally planned that this congress should meet in the autumn, but the date was changed and the preliminary arrangements were made without consultation with American scientific men. The officers of the congress, selected presumably by the department of state, are Mr. Phillips, the third assistant secretary of state, chairman of the executive committee; Mr. Scott, secretary of the Carnegie Endowment for International Peace, vice-chairman; Mr. John Barrett, secretary-general; and Mr. Glen L. Swiggett, assistant secretary-general. The department of state is probably as ignorant of the scientific condition of the country as the navy department, whose secretary when asked why he had ignored the National Academy, by law the scientific adviser of the government, and the American Association, the great democratic body of scientific men, in selecting the societies to elect members of the Naval Advisory Board, appeared never to have heard of either association. A program in nine sections has been arranged for a "scientific" congress, which ignores mathematics, physics, pure chemistry, geology, zoology, botany and psychology.

However, attempts have been made to rectify the earlier errors. Dr. Welch, president of the National Academy of Sciences, has been made honorary vice-chairman, and Surgeon General Gorgas, Dr. Holmes and Dr. Woodward have been added to the executive committee. The conflict in time does not extend to the second week of the Pan-American Congress, and it is probable that after the adjournment of the Columbus meeting a special meeting of the American Association will be held at Washington. Under existing conditions, it is extremely desirable that friendly relations and cooperation in science should be maintained among the American Republics.

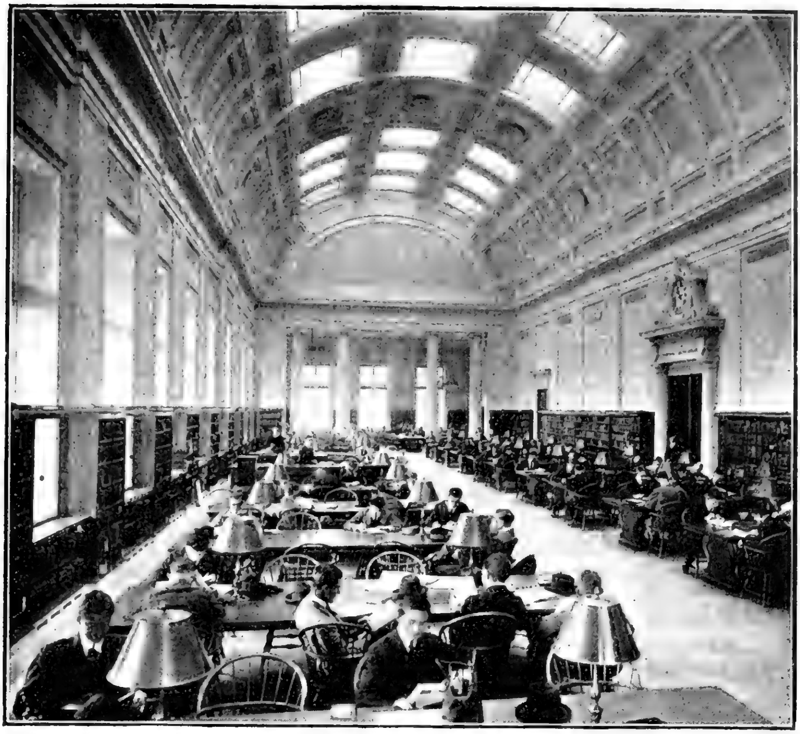
THE WIDENER MEMORIAL LIBRARY OF HARVARD UNIVERSITY

THE corner-stone of the Harry Elkins Widener Memorial Library was laid on June 16, 1913, and two years later, on Commencement Day, June 24, 1915, the dedication of the then completed building took place. The architect was Mr. Horace Trumbauer, of Philadelphia,

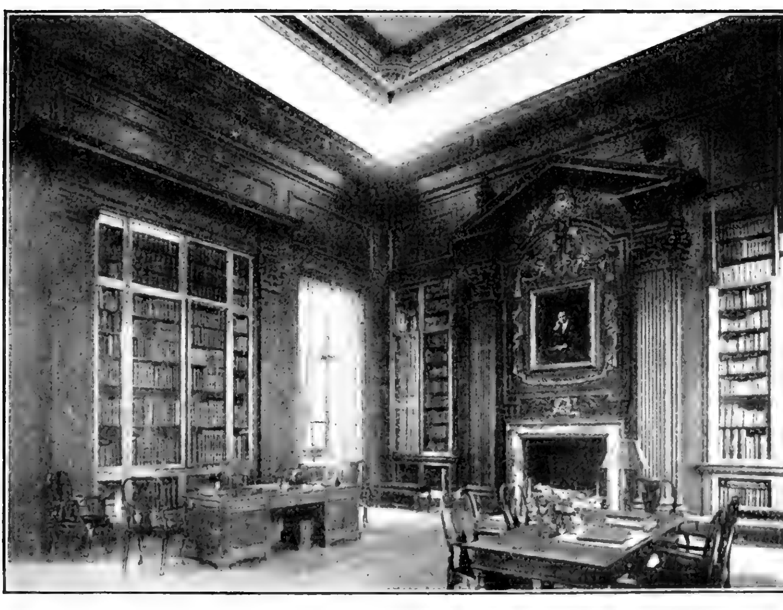
and the general contractors were George F. Payne and Company, also of Philadelphia. The building, of brick and limestone, is in the Georgian style of architecture, and is practically of fireproof construction throughout. It is in the form of a hollow square, measuring about 200 x 250 feet on the outside. The building faces the north; a broad flight of steps, surmounted by a colonnade of twelve massive columns, leads to the main entrance. The entrance hall, fifty feet long and thirty-six wide, is lined with Botticino marble, with a double row of columns of veined statuary marble. To the right a corridor leads to the director's office and to the room for the library council. Back of this is the treasure room, devoted to the safe keeping of the library's rarest books and specially fitted with locked metal bookcases. In front and immediately to the right of the entrance is another large room that is eventually to be used for a select library of standard books that shall be accessible to all comers without formality. A corridor to the left leads to the librarian's office and to the rooms of the order and catalogue departments. In the latter is



ENTRANCE HALL.



READING ROOM.



WIDENER MEMORIAL ROOM.

contained the official catalogue of the library.

From the entrance hall stairs lead directly to the Widener memorial rooms; one is a reception hall finished in white Alabama marble, the other, finished in carved English oak, contains Harry Widener's library. At the landing in front of the Widener rooms the main stairway divides and leads on each side to the second floor. Here, occupying the whole front of the building, is the main reading room. This room, together with the periodical room adjoining it at the west end, has seats for 292 readers. At the east end, opening both from the hall and from the reading room, is the delivery room where the public card catalogue is placed.

On the third floor, which rests on top of the stacks, are thirty-four rooms used for some of the special libraries, for seminary rooms, and for studies. There is also a large room for the library's collection of maps. Among the special libraries accommodated here are the Child memorial, the Lowell memorial, the French, German and Sanskrit, the mathematical, and those of the Business School and the Bureau of Municipal Research. The collection of theatrical material recently presented to the library by Robert Gould Shaw, of Boston, is placed in two rooms on this floor.

On the ground floor, on the west side, is a special reading room for elementary work in connection with the courses in history and economics. This has a separate entrance and provides seats for 166 readers. The rest of this floor is used for various working purposes. Below this is a basement, which at present serves mainly to accommodate the machinery necessary to run the building, but will eventually provide storage space for many thousand volumes.

The book-stacks, which run round three sides of the building, comprise ten floors, but for the present the two lower floors are not to be used and are therefore not equipped with shelving. The capacity of the stacks as at present shelved is about 1,433,000 volumes; with closer shelving and the addition of the two lower floors the total capacity should be about 2,200,000 volumes. Besides this, there is room for several hundred thousand volumes in other parts of the building. A distinguishing characteristic of the stacks is the series of reading-stalls along the sides of the principal floors. There are three hundred of these stalls. In addition to this provision for the comfort of students, there are over sixty small rooms that can be used as private studies for professors or visiting scholars.

These facts are taken from a brochure, prepared by Mr. A. C. Potter, assistant librarian, which gives an interesting history of the library and an account of its collections. In 1638, Harvard College received three hundred and seventy books—mostly theological—bequeathed to it by John Harvard. In the course of a hundred and fifty years the library increased to 13,000 volumes. Since then it has grown in a geometrical ratio, doubling about each twenty years, until now the number of volumes is 675,000.

SCIENTIFIC ITEMS

We record with regret the deaths of Orville Adelbert Derby, chief of the geological survey of Brazil; of Carl Axel Robert Lundin, maker of many of the largest telescopes in the world; of Raphael Meldola, professor of organic chemistry in the University of London, and of Dr. Henry Charlton Bastian, the distinguished London neurologist, the author also of books on the origin of life.

Sir J. J. Thomson, Cavendish professor of physics at Cambridge, has been elected president of the Royal Society, in succession to Sir William Crookes.

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THE AVOIDABLE LOSS OF LIFE

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As a nation, we are moved to immediate action by the loss of a few hundred lives in a spectacular way, but the deaths of thousands of our fellow citizens from avoidable, but insidious causes do not interest us in proportion to the loss involved or stimulate us to the necessary efforts of prevention.

The burning of a theater with the loss of several hundred lives is reported as a disaster and is followed by legislation making public buildings safe, but whooping cough, which destroys annually 10,000 persons and renders 190,000 ill, is frequently not listed as a notifiable infectious disease. We are horrified at the European conflict, but the combined loss of all the navies engaged is less than the number slain each year in this country by the typhoid bacillus. In a modern battle, 100,000 men may be killed and wounded, but the tubercle bacillus slaughters 147,600 of our citizens yearly, and a million and a half remain infected, the greater number of which will die of tuberculosis.

Were we to consider, in addition to communicable disease, the unnecessary loss of life and health associated with industries involving the handling of poisonous metals; the breathing of dangerous gases; the inhaling of injurious dust; the accidents of mining, transportation, construction and negligence—in fine, the preventable deaths and sickness due to occupation and carelessness—we would have a list of dead and injured unequaled by any of the warring nations of Europe.

As it is our purpose to consider, briefly, the mortality and illness due to the more common diseases and their prevention, we shall not discuss the industrial and accidental causes of loss of life and health farther than to note that Andrews estimates, on the basis of the careful results of German experience, that we have in our midst each year, at least, 13,500,000 cases of industrial sickness. Hoffman states that there are approximately 82,530 deaths, annually, in the United States due to accidents, and that in connection with the carrying on of dangerous industries, there are 25,000 deaths and 700,000 injuries involving a disability of longer than four weeks.

It is impossible to determine accurately from the last available statistics (1913) the exact number of deaths in continental United States due to a given disease, for 65.1 per cent. of the population only is included within the registration area. We may, however, obtain the approximate number of deaths for the country by using the rates of mortality per 100,000 population in the registration area and then computing the number of deaths on a basis of 100,000,000 inhabitants, the Census Bureau estimate for April 2, 1915. Such a computation is very conservative, for it does not include failures to report deaths and it places the Registration Area and Non-Registration Area on an equality, a classification, which, if appreciation of vital statistics may be taken as a standard of the attitude of a state towards public health, certainly does not underestimate the sanitary excellence of the non-registration area. The registration area contains but few of the states having large negro populations.

Communicable Disease

Over 500,000 people die of communicable disease each year in the United States and over five millions are sick as a result of infection. Had such a loss of life and health been localized, a city the size of Cleveland would have been depopulated and every individual in two cities the size of Chicago would have been in need of medical attention.

The immediate death rate and illness of infectious disease are scarcely more important than those of their complications and sequelæ. Measles and whooping cough prepare the soil for tuberculosis; scarlet fever for renal disease; rheumatic fever, tonsillitis, pneumonia, and syphilis for cardiac failure; and, infectious disease, in general, and syphilis in particular for vascular degeneration. The effect of sequelæ are well illustrated in the recent studies of Dublin in connection with typhoid fever. He noted that the death rate among typhoid survivors for the three years following the attack was twice the expected mortality for an equal number of individuals of the same age, sex, and color. Of those dying within three years following recovery, tuberculosis caused 39 per cent. of the deaths and heart disease 14.8 per cent. Dublin estimates that 8,000 deaths occur in the United States each year among persons who have had their vitality so impaired by typhoid fever that they succumb within the first or second year after recovery.

On account of long association with measles and whooping cough, the public has come to regard their presence as to be expected and of slight consequence to either the individual or to the community. In view of the fact that they are often more severe in adults than children, many parents make little effort to prevent the exposure of their children or to protect others.

Such an attitude is unsupported by the facts, for both measles and whooping cough, when considered in connection with their complica-

tions and sequelæ, are serious diseases, especially in very young children. Twelve thousand persons die of measles in the United States annually, and ten thousand of whooping cough. 81 per cent. of the deaths due to measles and 95 per cent. of those caused by whooping cough occur in children under five years of age. Obviously, the more cases the greater the number of deaths of young children, the more numerous the instances of deafness due to measles, and the more the number of individuals left a well-prepared soil for other infections. The failure of the mortality rates of measles and whooping cough to show a reduction during the last fifteen years is due to the fact that they are highly communicable in their early stage when diagnosis is most difficult and to the attitude of the public.

While it may be difficult to influence the morbidity of these diseases, the problem of the reduction of the mortality is 95 per cent. one of preventing children from acquiring the disease until they are ten years old. If parents were so informed as to realize the seriousness of measles and whooping cough and their sequelæ, the methods for control and isolation, and the grave responsibility that rests upon the individual who causes a child to be exposed, there would be such an effort to protect young children that there would soon be a decline in the mortality rates.

Scarlet fever causes the loss of nearly nine thousand lives, 82 per cent. occurring before the tenth year of life. Scarlatina is difficult to control, as its cause is unknown and mild cases may occur which are almost impossible of detection, but which serve as a focus for further spread of the disease. It is certain, however, that many unnecessary cases of scarlet fever are due to lack of care of the attendants upon patients; the non-pasteurization of milk; the failure to give thorough disinfection; the absence of adequate medical inspection of schools; and to imperfect isolation and too short quarantine. The deaths due to the failure to use effectively the well-recognized methods of prevention could and should be avoided.

Diphtheria and croup are responsible for the death of 18,000 people annually; 88 per cent. within the first decade of life. The fatal cases of croup are usually the work of the diphtheria bacillus. The number of deaths due to diphtheria have almost uninterruptedly decreased during the last fifteen years and, at present, are less than one-half that of 1900. As striking as this decrease may be, the mortality is much too high for a disease of known etiology, of well-recognized epidemiology, and one for which we possess a specific preventive and curative therapy.

The spread of diphtheria may be by carriers, improper isolation, incomplete disinfection, contaminated articles, direct contact with patients, and the failure to require repeated cultures from the nose, as well as from the throat, before the raising of quarantine.

The mortality of diphtheria is almost entirely dependent upon the time of the administration of antitoxin. If it is given in sufficient dose within the first twenty-four hours, practically all patients will recover; if withheld beyond the first day, the death rate increases with each hour. The delay in receiving antitoxin is usually due to the slowness of the patient to obtain medical attention and the waiting on the part of the physician to determine the nature of a suspicious sore-throat clinically, rather than bacteriologically.

We may expect much greater reduction in the number of deaths from diphtheria by isolation and bacteriological examination of all suspicious sore-throats, by rigid enforcement of quarantine, by greater effort to discover and eliminate carriers, by education of the public as to the need of early obtaining medical advice and to the necessity of the quick administration of antitoxin.

In 1913, there were about 18,000 deaths from typhoid fever and approximately 180,000 cases. Happily, this is a reduction of 50 per cent. in 12 years, but the rate is still inexcusably high. Typhoid fever so impairs the vitality of the individual that his mortality is twice the expected death rate during the three years succeeding the attack and in this way, according to Dublin, is responsible indirectly for the loss of 8,000 lives annually.

Typhoid fever should be eliminated. Improvements in water supplies, scientific sewage disposal, the protection of milk, meat and vegetables from contamination, the anti-fly campaigns, and, perhaps, the adoption of typhoid inoculation have been largely instrumental in lowering the death rate from 35.9 per 100,000 population in 1900 to 17.9 in 1913.

The contact of a large number of individuals aids in the dissemination of typhoid fever, yet the death rates of our largest cities, which take precautions against the typhoid bacillus, are about one third the rate for the entire Registration Area. While certain large cities have shown great progress in the reduction of typhoid fever, the sanitation of the rural section of the country is in its infancy and in many of the smaller towns and villages, the insanitary privy and polluted well are menaces to the health of the community.

Typhoid and cholera have much in common; both are of well-known etiology, are of similar epidemiology, and both owe their prevalence to the transference of the excreta of one individual to the alimentary tract of another. They differ in that cholera is explosive in its onset, has a higher mortality, and is widely disseminated at certain times and places, while typhoid fever is almost ubiquitous, and, on account of the length of its incubation and the insidiousness of its inception, its origin may be difficult to trace.

Cholera has been rather widely spread in the United States, but

scientific methods intelligently and vigorously applied have driven it from the country and prevented it from gaining a foothold in any of our sea-coast cities by importation from abroad. Cholera with its sudden onset, its rapid spread, and high mortality is impressive, and has so stamped itself in the public mind, that the possibility of its introduction into the country is a cause for a popular demand for the exercise of every precaution against it.

Were we to adopt the same attitude towards typhoid fever, unnecessary contact with it would be avoided, no convalescent would take his place in society until a competent bacteriologist had assured him it was safe to do so, carriers would be placed under supervision, insanitary privies would be abolished, sewer connection would take the place of the cess-pool, milk would be pasteurized, food would be insured against contamination, water supplies would cease to be questionable, sewage would receive proper disposal, the fly would be exterminated, inoculation would be exceedingly popular, and typhoid fever, like cholera and yellow fever, would become a matter of history.

It is impossible to determine the extent of syphilis, a disease protean in its manifestations, variable in its intensity, chronic in its tendency, and hereditary in its scope. It may be conservatively estimated that there are at least a million and a half syphilitics in the United States. In 1913, syphilis was directly responsible for 7,200 deaths, for 6,900 due to paresis, and 2,600 caused by locomotor ataxia. It attacks the vascular system with special severity and is a great factor in the mortality due to insufficiency of the aortic valves, aneurism, arterio-sclerosis, certain groups of cases of angina pectoris, and cerebral hemorrhage. Syphilis produces over 26 per cent. of all stillbirths and holds an important place as a cause of death within the first year of life. Nearly 20 per cent. of the first entrances to the institutions for the insane are due to this disease. There is an increased mortality rate among syphilitics of 70 per cent., which means a reduction of the average expectancy of life by five and a half years.

In the presence of the ravages of this scourge of the human race, the one thing that stands out most conspicuously is the ability to prevent it. The moralist would attack the problem of syphilis by clean living, the abolition of prostitution, by instruction of the youth in regard to the danger of venereal disease and would discourage the postponement of marriage. These measures would be the happiest, the most efficient and certainly the most desirable means of prevention, but, on account of the frailty of human nature and the strength of the sexual instinct, are most difficult of general application. The sanitarian would utilize the full force of ethics, but, in addition, would urge the establishment of hospitals for the early diagnosis and prompt treatment of syphilis, would educate the public in the means of prophylaxis,

and would make it a criminal offense for one individual to knowingly transmit the disease to another.

Syphilis would be as infrequent as malaria if the public understood thoroughly the danger of venereal disease, knew the importance of early treatment both for the syphilitic and for the protection of his associates, appreciated the need of instruction in prophylaxis, and realized the necessity of the state establishing institutions for free treatment as a sanitary measure for the protection of its uninfected citizens.

The facilities for the treatment of syphilis on an extensive scale are as inadequate as necessary. Pusey has admirably described the attitude of the hospitals towards this disease.

> Most public hospitals . . . assume the unconscious attitude that the syphilitic is responsible for his own misfortune, and of all the sick, except those with other venereal diseases, is least worthy of charity; ignoring the fact that, worthy or unworthy, he is a public danger, and the greater danger the more unworthy and vicious.

Our civilization must approach the stage when all lovers of mankind will drag forth this ghastly form which for centuries has concealed itself in the shadow of prudery and let it shrivel and die in the full light of public knowledge and in the presence of a triumphant Preventive Medicine.

Pneumonia destroys annually 132,400 lives, is the most prevalent and most fatal of all the acute communicable diseases. Its occurrence has shown considerable reduction during the last thirteen years, falling from 180.5 deaths per 100,000 population in 1900 to 132.4 in 1913.

It occurs as a primary disease; as secondary to measles, scarlet fever, whooping cough, diphtheria, influenza and typhoid; at both extremes of life—causing the death of young children and enabling elderly sufferers to easily exchange a life of invalidism for a peaceful grave.

Pneumonia is caused most frequently by the pneumococcus, but it also may be due to other organisms. It was commonly believed that pneumonia was an autogenic infection, for a pneumococcus was to be found in the oral and respiratory passages of a large proportion of healthy individuals, and that the lowering of the vitality by exposure to cold, by inhalation of dust or fumes, alcoholism, injury to lung tissue, or senility so disturbed the balance between the virulence of the organism and the susceptibility of the individual as to present a favorable opportunity for development of the disease. This conception does not agree with recent observations, which seem to indicate that the disease is due to contact with patients or with healthy carriers.

The prevention of pneumonia requires isolation of the patient, disinfection of his expectoration, and the avoidance of all things which

tend to lower the vitality of the individual or to favor the spread of the disease by carriers. The increased opportunity for infection in cities owing to crowding demands the allaying of dust, and adequate ventilation of theaters, schools, cars and public buildings. Occupations requiring excessive fatigue, exposure to unsuitable temperatures, and to dust or fumes should be under the supervision of a sanitarian and so modified as not only to add to the efficiency of the worker, but to afford him an opportunity to increase his resistance to disease. The occurrence of pneumonia may be reduced, individual susceptibility decreased, and the devitalizing influence of modern life successfully overcome by proper exercise, the abundance of fresh air at night, as well as during the day, sunlight, sensible clothing, sufficient and suitable food, cold baths, enough sleep, attention to oral hygiene, and by the avoidance of exposure, excessive fatigue and alcohol.

Tuberculosis caused 147,600 deaths in 1913. The mortality rate of tuberculosis has markedly declined, falling from 326.2 per 100,000 population in 1880 to 147.6 in 1913. The decrease has been uninterrupted since 1904. There are approximately a million and a half individuals suffering from tuberculosis in the United States.

The medical profession and the public have more consistently endeavored to prevent tuberculosis than probably any other communicable disease, but, in spite of their efforts, it is of the first importance among the causes of death and is still "The Great White Plague," "the captain of the hosts of death."

Tuberculosis is the unfortunate result of the combination of the tubercle bacillus and a lowered vitality. The necropsy findings and the Von Pirquet cutaneous reaction show that few persons pass through life without being infected. The failure of more individuals to have symptoms of the disease is due to their resistance and the number of bacilli taken into the body at one time.

The prevention of tuberculosis begins at birth and is a two-fold problem—avoiding infection and increasing the resistance of the individual.

Infection may be avoided by providing sanatoria for segregation and treatment of the tuberculous, the protection of the milk supply by testing of the cattle or by pasteurization, anti-spitting regulations, proper disposal of the sputum, and education of the public. Early diagnosis is of the utmost importance, for the sooner the disease is discovered, the greater the chance for successful treatment and the earlier the opportunity for the protection of others. With proper education of the public, it will be practical to make a diagnosis of "A fertile soil for tuberculosis" before unmistakable symptoms are present and without causing the individual or his friends unnecessary distress. In a person underweight, "a little run down," a poor eater, "rather nerv-

ous" and easily fatigued, the stage is set for tuberculosis. In such an individual, the time for rest, better food, fresh air, and change of environment has arrived. The moment for rescue is before the rapids are reached, not when the passage of the precipice is inevitable.

The increase of resistance to tuberculosis is economic and sociologic. Good food, fresh air, sanitary houses and places of occupation, sufficient sleep and the avoidance of overwork and overworry, the essentials of a normal existence, are obtainable for the well-to-do, but not for the poor. Tuberculosis is an ally of want and squalor, and is becoming more and more the disease of the overcrowded, the underfed and the overworked. Until social and economic conditions make it possible for each individual to have enough sleep, abundance of clean fresh air, sanitary housing, sufficient rest and proper food for growth and energy, society may expect to reap a harvest of tuberculosis.

Infantile Diarrhea

There are 75,200 deaths, annually, due to diarrhea in children under two years of age, a mortality exceeding the sum of the deaths caused by measles, scarlet fever, whooping cough, diphtheria and typhoid fever by 6,000.

This loss of life is mainly preventable. It is due to summer heat, want of care, ignorant feeding, improper food and bad hygiene. Many of these deaths would be avoided if maternal feeding was more common. Holt has shown that the death rate of the artificially fed infant to the breast nourished is in the ratio of 32 to 1. Maternal feeding requires little effort or care; artificial feeding demands intelligence, judgment and the means for the purchase of the proper food. Artificial feeding *per se* is not to blame, but ignorant feeding, the giving of contaminated or improper food or the failure to modify the quality and quantity of clean wholesome food to meet the needs of each child.

Heat seems to bear a direct relation to the occurrence of "summer diarrhea." It affords a better opportunity for the growth of bacteria in the child's food, and for an increase of the normal flora of the intestine. It may so influence normal digestion and metabolism as to lead to the formation of toxic substances which may cause diarrhea.

Enteritis may be largely prevented by maternal feeding. The distribution of clean milk and the instruction of the mother in its modification to meet the special needs of her child, will do much to reduce the incidence of diarrhea. Strict attention should be given to the cleanliness of the nursing bottles, nipples, and to the hygiene of the baby. The clothing of the child should be determined by the temperature rather than by tradition. Congested living quarters should be avoided and the infant should be kept out of doors as much as possible. The months of July and August should be spent in the country; if this is not feasible, the child should have the full benefit of the parks.

THE DEGENERATIVE DISEASES

Deaths due to lesions of the heart, kidneys and blood vessels, the diseases of old age, are on the increase. They are becoming more frequent before fifty and many individuals are dying prematurely, at an age when, as a result of training and experience, they should be most productive and of the greatest value to society.

In 1913, there were over three hundred thousand deaths due to diseases of the kidneys, heart and blood vessels. 24.2 per cent. of all the deaths due to Bright's disease and 21 per cent. of those caused by organic heart trouble occurred in individuals under fifty years of age. Cerebral hemorrhage and arteriosclerosis have increased during the last ten years.

The strenuousness of modern life, the intemperance of food and drink, exposure and the intoxications of occupation play a part in the production of renal, cardiac and vascular degeneration. In many cases, however, we see the hand of syphilis, the sequel of rheumatic fever, tonsillitis, chorea, and of pneumonia, or the probable latent injuries of scarlet fever, diphtheria, typhoid, or malaria.

In the acute cases of kidney, heart, or vascular disease, the virulence of the invading organism, the reduction of the resistance of the individual, or both, so favor the spread of the infection that signs of disease are early apparent. In the chronic cases, the injuries may be comparatively latent, the symptoms slight or absent, yet the organs may be so damaged that under the stress of modern life their period of activity may fall short ten or twenty years.

It matters little whether the premature deaths of the individuals, at a time when they are most useful, is due to infectious disease, the poisoning of occupation, the wear and tear of existence, overwork, or to the excess of food or drink, the power of prevention rests largely with the individual and the state.

On the basis of the last statistics, there are 78,900 deaths due to cancer annually in the United States. The mortality rate has steadily increased from 63 per 100,000 population in 1900 to 78.9 in 1913. Do these figures represent an actual increase? Statisticians and notably Hoffman believe that the mortality rates, "unconditionally confirm the conclusion that cancer is relatively on the increase throughout the civilized world and the increase is affecting practically all important organs and parts of the body." Physicians and surgeons are somewhat skeptical and are inclined to attribute the increase largely to better methods of diagnosis of internal cancer and to the lengthening of the average life which increases the number of individuals reaching the cancerous age.

The etiology of cancer is unknown. It is a "disease of theories" and

each theory has some evidence to support it, but which is inadequate to establish it to the exclusion of others.

The two great predisposing causes of cancer are age and irritation. Cancer usually occurs after forty, but it may not uncommonly appear earlier in life. Any source of irritation, be it mechanical, as the effect of a jagged tooth on the cheek or tongue; actinic, as the action of the Röntgen or ultra-violet rays upon the skin; thermic, as the effect of a hot pipe stem upon the tongue or lip; or chemic, as the action of arsenic and anilin dyes upon the skin, predisposes to cancer.

The prevention of cancer depends upon the education of the public as to the dangers of chronic irritation, as to the importance of the early symptoms and the necessity of an early operation. It should be universally known that any lump in the breast or unusual bleeding from the uterus in a woman above thirty-five requires investigation to exclude cancer. Sores, warts, and swellings of the lips or tongue in an individual over forty should be brought immediately to the surgeon for diagnosis. Bleeding from the bowels of a person of similar age demands the exclusion of cancer. Warts or moles that begin to show signs of growth or soreness should be removed at once. Suspicious growths should be given expert microscopical examination. All the precautions used against external precancerous lesions should be taken to avoid and discover beginning internal cancer. The best way to make a curable cancer hopeless, is to delay operation or to use plasters and salves.

Economic Importance of Preventable Disease

Society is demanding each year greater skill and increased efficiency of its members, a requirement that calls for a larger investment in the training of the individual and a condition that makes the economic loss due to preventable disease most appalling. So many factors contribute to this waste that it is practically impossible to state it in figures.

Nine tenths of all children dying of measles, whooping cough, scarlet fever and diphtheria, and all those dying of diarrhea or any diseases before the tenth year represent a total loss, for economic values have been created and destroyed without giving return.

The toll of syphilis, typhoid fever and tuberculosis is heaviest during the period of greatest usefulness. The ravages of syphilis are large between thirty and forty-five, but greatest between forty-five and sixty. It shortens the expectancy of life by 5.5 years; it renders the individual inefficient during the most productive period of life; it fastens itself upon the posterity of its victim, increasing degeneracy, encouraging poverty and promoting public charges; it erects about 20 per cent. of our insane asylums and taxes the nation for their maintenance. Typhoid fever causes 94 per cent. of its mortality before the sixtieth year, over 48 per cent. before the twenty-fifth year, and about 29 per cent.

between the fifteenth and twenty-fifth year. Tuberculosis destroys 90 per cent. of its victims before sixty, 30 per cent. before twenty-five, and 19 per cent. between the fifteenth and twenty-fifth year. Tuberculosis and typhoid fever not only strike down over 90 per cent. of those attacked before sixty, but they cause tens of thousands to seek public charity or to spend large sums to recover their health, when they should be producing. Nearly one third of the deaths due to typhoid and one fifth of those caused by tuberculosis occur in the high-school-university period of life, the time representing the maximum investment of society in the preparation of the individual for usefulness.

Diseases of the heart, kidney and blood vessels are becoming more frequent, thus individuals are prematurely lost to society who by training and experience should be of the greatest value.

The great economic loss due to the deaths of individuals before they have become an earning power and of persons dying during the most productive period of life is relatively small as compared with the enormous loss caused by illness with its consequent loss of time of the wage earner, the inefficiency of the worker, the expenditures for medicine and attention and the absence or decrease of productiveness on the part of other individuals who must spend a part or their entire time in caring for the sick.

It is obvious that this large loss of life and health constitutes a serious curtailment of the productive efficiency of the nation and that a heavy economic burden results from the support of invalids, defectives and those deprived of their bread winners. As long as preventable diseases are present, we are paying large premiums to keep them, for it would be much cheaper to prevent, than to have them.

Prophylaxis

Preventable disease is associated inseparably with poverty and ignorance, and any successful attempt at prevention must be an attack upon these twin brothers of human misery.

Poverty may be the great predisposing cause of disease or the result of it. Poverty by underfeeding, overworking and poorly housing renders the individual more susceptible to disease; by overcrowding presents a favorable opportunity for the spread of infection. The English Royal Commission on Poverty states that 55–60 per cent. of the poverty of Great Britain is due to sickness. The report of the Charity Organization of New York City seems to confirm the figures of the Commission.

The poverty-stricken individual is a fourfold menace to the nation—a poor progenitor, an inefficient producer, a potential source of disease, and frequently a malcontent. Society should realize that every individual who makes his best efforts and every child born to the nation must

be guaranteed as their inalienable rights sufficient food for growth and energy, the necessary amount of sleep and rest, abundance of fresh air, sanitary quarters, and an opportunity for an education. A different attitude fails to promote the general welfare, procreates weaklings, invites disease and undermines the stability of the nation.

Ignorance can be removed only by education, and if the intelligent individuals of every community who realize the serious importance of disease to the nation, are to be interested and increased in numbers until they will demand preventive machinery commensurate with scientific knowledge and the enactment of laws founded upon the present development of preventive medicine, public education must be pushed with greater vigor.

Much has been accomplished by popular literature, lectures and demonstrations, more will be done by them in the future, but the importance of preventable disease upon the social and economic conditions of the nation demands more than an occasional public lecture, pamphlets at infrequent intervals or casual demonstrations. Instruction in the methods of preventing disease should be an essential part of our system of education and no individual should have completed his education without the knowledge of how communicable diseases are spread and prevented; the dangers of and the methods of avoiding industrial disease; how to care for an infant; and a practical understanding of sanitation and hygiene. A system of education that requires large sums of money to teach individuals English and science and does not instruct them how to protect themselves from preventable death and illness, fails to insure its investment and may be criticized as incomplete.

Each county should have a full-time health officer and community nurses to meet the needs of the population. Their duties should be threefold: the control of disease, the education of the public, and as expert consultants for the citizens of the county upon matters of hygiene and sanitation.

With such a force it would be possible to make a sanitary survey of each industrial plant, place of amusement, summer resort and residence. Such a survey would reach a large number of persons who are not likely to hear public lectures or to read popular literature. A visit and a tactful conference of the health officer and property owner have not only a sanitary and educational value, but they create a sympathetic understanding between the citizen and the sanitarian, a condition essential to the practical progress of sanitary science.

Every large industrial plant should carefully supervise the physical condition of its employees, for the health of the workman determines his daily efficiency and the period of his productivity. Periodic physical examination of all employees would detect disease in its incipiency;

would contribute largely to community health; and would make it possible to adapt the work to the physical condition of the worker. There would be an economic gain to the employer by the reduction of the number of accidents to workmen, material and machinery; in protection against unjust claims for compensation; in the increased efficiency of the worker; and in the decreased loss of time from preventable sickness.

The prevention of disease is the function of science and society. Science must provide the way; society must use the means and bear the cost. The acceptance by society of Jenner's demonstration of the advantage of vaccination ended the devastation of smallpox; with the practical application of the discoveries of Laveran and Ross, malaria ceased to be the scourge of mankind; the use of the knowledge of Reed, Carroll and Lazear made the Panama Canal a possibility and closed our ports to yellow fever; our understanding of the life history of the Koch vibrio has kept Asiatic cholera beyond our shores; and a scientific attack upon plague has prevented its spread and practically driven it from the country.

The knowledge of tuberculosis is as complete as that of plague; the epidemiology of typhoid fever and cholera are practically identical; the understanding of syphilis is as clear as that of malaria; and the information concerning diphtheria as definite as that of yellow fever. The way for the great reduction or elimination of preventable disease is known; the need is for society to educate its members, use the methods, and bear the cost.

THE CAUSES OF WAR

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A SUPERFICIAL consideration of the many wars of the past might lead one to think that the causes of war are as numerous as the wars themselves. There are interesting accounts of wars having been occasioned by trivial causes. A dispute over a pig is said to have threatened war at one time between the United States and Great Britain; at another time, between France and the then republic of Texas.[1] The war of 1738 between England and Spain, which later became a part of the great war of the Austrian Succession, is known in history as "Jenkin's Ear War," the actual occasion being the maltreatment by the Spaniards of an old English sea captain, resulting in the loss of an ear.[2]

If we distinguish, however, between cause and occasion, we find that, while the occasions of war are many and varied, the causes are few. This fact has been pointed out by Lecky with respect to the wars of Europe. He says:

> If, indeed, we examine only the proximate causes of European wars, they present the aspect of a perfect chaos, and the immense majority might be ascribed to isolated causes or to passing ebullitions of national jealousy. But if we examine more closely, we find that a deep-seated aversion produced by general causes had preceded and prepared the explosion. The great majority of wars during the last 1,000 years may be classified under three heads—wars produced by opposition of religious belief, wars resulting from erroneous economical notions, either concerning the balance of trade or the material advantages of conquest, and wars resulting from the collision of the two hostile doctrines of the divine right of kings and the rights of nations."[3]

Thus, according to Lecky, the causes of the wars of Europe may be reduced to three categories, namely: religious, economic and political. If, as the exponents of the doctrine of the economic interpretation of history maintain, both religious and political beliefs have an economic basis, these three sets of causes may be reduced to one, the economic. But whether history is to be thus explained or not, it is safe to say that the principal cause of the wars of Europe has been economic.

In the wars of primitive times the economic cause stands out conspicuously. Men lived in tribal groups; they were unacquainted with efficient modes of production; they were averse to labor. Savage tribes,

[1] See Macy, A. W., "Curious Bits of History," p. 160, and Wooten, Dudley G., "A Comprehensive History of Texas," Vol. 1, page 370.

[2] Cheyney, Edward T., "Short History of England," page 557.

[3] Rationalism in Europe, Vol. II., pp. 219–20.

rapidly expanding, naturally experienced increasing difficulty in obtaining a food supply. This led to nomadic habits or to migration. Roving bands, pastoral or hunting, in search of food, came into collision. The result was war, followed in primitive times by cannibalism, later by general exploitation and slavery. Says Robinson:

> Among tribes subsisting on the products furnished spontaneously by nature war is the normal condition. The reason is, in the main, economic. The scarcity and precariousness of the food supply render much land necessary to support each family. Unless climatic conditions absolutely prevent an increase of population, the hunting grounds of the several tribes are of necessity extended until they overlap; and so arises a war of extermination, whose issue is the destruction of the least efficient social organization and the restoration of the equilibrium between population and the food supply.[4]

The tribal wars of the American Indians may be taken as an illustration. The Algonquin and Iroquois tribes met and fought in the fine hunting grounds of the Mohawk valley; the Shawnees, Delawares, and Miamis, in Kentucky, "the dark and bloody ground."

So also the economic cause is plainly visible in the early wars of history, whether they took place in Europe or in Asia. In the earlier civilizations there was periodically a swarming of the hive, as one might say, great migrations, *Völkerwanderungen,* which necessarily meant contact with other civilizations and the resulting contest for food, wealth and the other material things that men most desire. The very nature of these early wars is indicative of the fact that they were due primarily to an economic cause.

The same thing is true, although less conspicuously so, of the later wars of history. It was so of the early wars of Greece and Rome, of the wars of feudal times, of the series of contests between the various maritime powers, of the wars of the Palatinate, of the war of the Spanish Succession, and of the American Revolution. Even the so-called religious wars are reduceable to an economic basis—the crusades, for example. Says Molinari:

> Lorsque l'expérience eut démontré que les croisades ne payaient pas on y renonca et les guerres d'expansion des peuples de l'Europe ne recommencèrent qu'après la découverte de l'Amerique.[5]

The wars of Napoleon, and many of those since his overthrow, as, for instance, the Crimean war, the Chinese wars, the Mexican war and our own great Rebellion, have been largely if not chiefly due to economic questions, either with respect to the acquisition of trade or of trade routes. The same may be said of the present war in Europe. If we penetrate beneath the superficial phenomena—the assassination of a crown prince, mobilization of armies, royal ambitions, national jealousies

[4] *Political Science Quarterly,* Vol. XV., No. 4 (Dec., 1900), p. 582.

[5] "Grandeur et decadence de la guerre," p. 49. Quoted by Robertson in the article cited.

and race prejudices—we find commercial rivalries, desires for an outlet to the sea, or "a place in the sun."

Wars in general, then, arise chiefly from economic conditions. In early times the principal motive was either conquest and the advantages arising therefrom or the securing or maintenance of some special economic advantage. Since the development of a money economy, and the consequent national interdependence, the possibilities of economic exploitation through conquest have gradually diminished, so that the idea that war is economically profitable to any of the countries concerned may well be regarded to-day as "The Great Illusion." Still, economic friction between the trading nations of the world is a patent fact, and it is to-day, as it has been in the past, the principal cause of international strife.

Other causes, of course, have occasionally risen into prominence, particularly the ambition of rulers; the desire of governing classes to aggrandize or protect themselves; national bumptiousness and aggressiveness, due chiefly to an ignorant and blind patriotism; and, as a minor cause, differences in philosophic tenets with respect to government. And so also the sentiment of nationality, considerations of national honor, the preservation of the wellsprings of national morality, which most people seem to think gush forth only in their own country; the attainment or the preservation of "the peace of righteousness"—which means, I suppose, the peace resulting from the victory of "our side" in a contest—all these, even if they have not occasioned war, have been paraded among the reasons that are marshalled by those who would justify war or even glorify it. But, after all is said, the fact remains that the causes of war have been and are to-day chiefly economic.

This being the case, it will be interesting now, and necessary to the general purpose of this discussion, to turn our attention to the nature of an economic cause.

The idea of cause is inseparable from the idea of force. Some kind of force is indeed the only efficient cause, whether it be in the physical, vital or social world. Now the forces which produce social results are the feelings. Feeling is the dynamic element in human society. Social conflicts, of which war is an example, can arise only from a conflict of feeling between the groups involved. If this conflict is due to a clash of economic interests we have, in the initiation of such conflict, the operation and manifestation of an economic cause. An economic cause, then, is mutual hostility of feeling arising from the competition of industrial groups of different classes or nations. To say, then, that the chief cause of war is economic is but to say that wars are due in general to industrial competition as carried on between the nations of the world.

But the industrial régime of the world has always been, and is now,

competitive. Nations are in constant competition for markets, for trade routes, for opportunities for expansion, or, more accurately, the trading classes of nations are in such competition. Some gain, others lose. Naturally, hostile feelings are evoked, government is appealed to, international disputes arise, and, becoming acute, wars are declared and are waged to promote the economic interests of the dominant industrial classes. The chief conditions that incite war, then, are inherent in our present system of industry. Indeed, the business of the world as carried on to-day is war, only it is veiled by certain conventions, too often by pretense and hypocrisy, and is transacted in general under the sanction of law. When the pressure becomes too strong upon the feelings, that is, when the conventional and peaceful means are insufficient to obtain the end sought, there is resort to arms. Armed warfare is only a phase of the general industrial warfare that prevails the world over.

Some deny this fact. They persuade themselves, or are persuaded by the biased arguments of those interested in maintaining things as they are, that the interests of the various industrial and commercial classes and nations are the same. But this is not the case. As Robinson well says, in the article already quoted,

> The dogma of the natural and necessary harmony of the interests of all nations is just as false as that of their natural and necessary antagonism. This dogma is true only so long as each nation has a natural monopoly in some one line of industry,—as the free traders erroneously assumed that England had in manufacturing. While competition is absent, commerce is, indeed, a bond of peace and good will between those who buy and those who sell in return. But the moment that two nations embark extensively in the same line of industry, that moment commerce becomes a sword, dividing and setting at enmity those who are rivals for the same markets. For of them it is true, as Montaigne declared, that no profit can be made except to the damage of another. The increase of one is the decrease of the other; the prosperity of one is the other's destruction. Such nations stand to each other as two Indian tribes when there is but game enough for one.[6]

Now the bearing of all this upon the immediate or early cessation of war is obvious. Wars are not likely to cease so long as the fundamental cause is operative, that is to say, so long as economic conditions and relationships remain as they are now. These conditions and relationships will continue to evoke strife, and, under the stress of passion, swords will be drawn no matter how unprofitable from a business standpoint war may be. This is not to assert that human weakness is the cause of war. It is the weight pressing upon the beam, not the weakness of the material, that causes the fracture. So war is due, not primarily to human weakness, but to the economic conditions in which this weakness is unable to bear the strain. There is no hope of permanent peace without a change in the conditions which make strife inevitable.

[6] Article cited.

The fact that commerce and business in general do in some respects make for peace has led many to suppose that the spread of commerce is fatal to the existence of war. Professor Shaler, writing in 1896, said:

> So long as the control of governments was in the uneconomic classes of men who had nothing to lose and much to gain by war, the influences were overwhelming for its continuance; now that the business people are gaining control of the world's affairs there is reason to hope that the cure is about to come to this ancient and enduring ill.[7]

But this hope is vain, as recent events have shown. So long as the economic interests of classes and nations are antagonistic there will be war. No demonstrations of its waste, no sentimental appeals for peace, will prevent it. Not the spread of commerce but the harmonization of economic interests is the most effective remedy.

The application of this remedy is conceivable, however impossible such application may be at the present time. A cause of war arising from economic conditions is not ineradicable. War is not due to anything inherent in nature or in man—not to hunger and the law of decreasing returns, as Robinson concludes. He says:

> The cause of war is as permanent as hunger itself; since both spring from the same source, the law of decreasing returns. So long as that persists, war must remain, in the last analysis, a national business undertaking, designed to procure or preserve foreign markets, that is, the means of continued growth and prosperity. *Chacun doit grandir ou mourir.*[8]

But hunger and the law of decreasing returns might conceivably lead, and ought to lead, to cooperative effort to produce food, rather than to war, which is an organized and systematic effort to secure it by robbery, and in which much of it is unprofitably consumed and destroyed. Might it not have been said in the earlier swashbuckler days, and with equal truth, or error, that "the cause of piracy and robbery is as permanent as hunger itself"; and yet "lifting" the goods of another, as a means of "growth and prosperity," has in general given way to other and more approved methods of gaining a livelihood. May it not be also that in time an improved industrial economy will provide a sufficient amount of material goods to maintain an intelligently restricted population? With the enormous possibilities of industry, intelligently organized and intelligently directed, the expectation that the maintenance of a nation's civilization by work rather than by war may at last be realized, and thus the economic cause of war be removed at all events, this expectation should not be regarded as an altogether empty and iridescent dream.

But granting the present impossibility of eliminating the economic cause of war by a revolutionary change in economic conditions, there remains the hope that through the dissemination of knowledge respecting the waste and futility of war as a mode of social action, and as a means of achieving social results, at least the frequency of war may be

[7] Shaler, N. S., *North American Review*, Vol. 162, page 340.

[8] Article cited.

lessened. Popular education, however, it must be admitted, has not fulfilled the early expectations with respect to its promotion of peace. It has indeed lamentably failed; for the results of increased popular intelligence and the advancement of science are manifested in the greater destructiveness of war, and apparently in its more savage brutality. The failure, however, ought not to be charged to education itself, but to the kind of education that has prevailed and to the dissemination of erroneous ideas concerning the nature and results of war—the ideas of Treitschke and Bernhardi, false conceptions of national honor and patriotism, and the pernicious idea that the best way to prevent war is constantly to think about it and prepare for it, an idea contradicted by all we know of human psychology with respect to the relation of thought to action. Education properly conceived as the distribution of scientific knowledge and the development of the social spirit would in time eliminate war and all the other remediable evils that afflict mankind. It is the sole panacea. But as a means of preventing war it needs to be reformed. And to begin with there should be scientific instruction with respect to the nature of war, rather than the inculcation of false ideas which tend to promote it.

The true nature of war, unlike its causes, is not obscure. It is plainly revealed by a knowledge of biological and social evolution. Such knowledge ought to lead to recognition of the distinction between the blind social evolution of nature, effected partly by war, and a possible ordered social evolution achieved by human foresight. But the study of evolution, the one study capable of rendering this great service, has been discouraged, sometimes forbidden, in our schools and colleges, on the ground of its being unorthodox or atheistic; hence the superstition of nature worship which prevails to-day. There is indeed a natural evolution of nations and societies. As Spencer says:

> It is true that much social evolution is achieved without any intention on the part of citizens to achieve it, and even without the consciousness that they are achieving it.[9]

But such evolution is uncertain, slow, wasteful and to no end save the adjustment of the social organism to its environment. It does not result in the survival of the best, but the fittest, and sometimes the fittest is ethically the worst. Its chief method is competition or war, both being essentially the same. This method, like all the methods of nature, is direct; it is the method of the brute. Says Professor Ward:

> War, however much the indirect method may be incidentally employed in its detailed management, is in its *ensemble* essentially a measure of direct coercion. The effects are no greater than the effort required to secure them. The action is exactly balanced by the reaction. The algebraic sum of the results of all wars is *nil*.[10]

[9] Spencer Herbert, "Various Fragments," page 132.
[10] Ward, L. F., "Glimpses of the Cosmos," III., 41.

It is the function of intelligence to supplant the direct method of evolution as manifested by war by the indirect method of foresight and control. Man is man only in proportion as he controls natural phenomena and supplants the method of nature by the method of mind.

The world ought not to await the complete work of education, however, before putting an end to war. Only a preponderance of intelligent opinion with respect to war is necessary, and the effective expression of this opinion through an organization that will restrain the rashly belligerent nation from running amuck. In other words, the world must organize to prevent war, by soft words if possible, but by the use of the "big stick" if necessary. Intelligent and law-abiding men did not wait for the conversion of all duelists to abolish dueling. When they felt the power to abolish it they did so. Said St. Louis, King of France:

> We forbid, to all persons throughout our dominions, the trial by battle... and instead of battles we establish proofs by witnesses . . . and these battles we abolish in our dominions forever.[11]

So the peace movement should be directed toward the formation of a league strong enough to forbid war and that would establish, instead of war, "proofs by witnesses." War is not only an evil, it is a nuisance, and the nation inclined to belligerency should be confronted by the notice, posted by the intelligent and law-abiding people of the world, "Commit no nuisance, under penalty of the law!"

[11] Guizot, "Histoire de la Civilization en France," LeCon 14, Vol. IV., pp. 162–4.

THE ISLANDS OF THE MID-PACIFIC

BY DR. ALFRED GOLDSBOROUGH MAYER

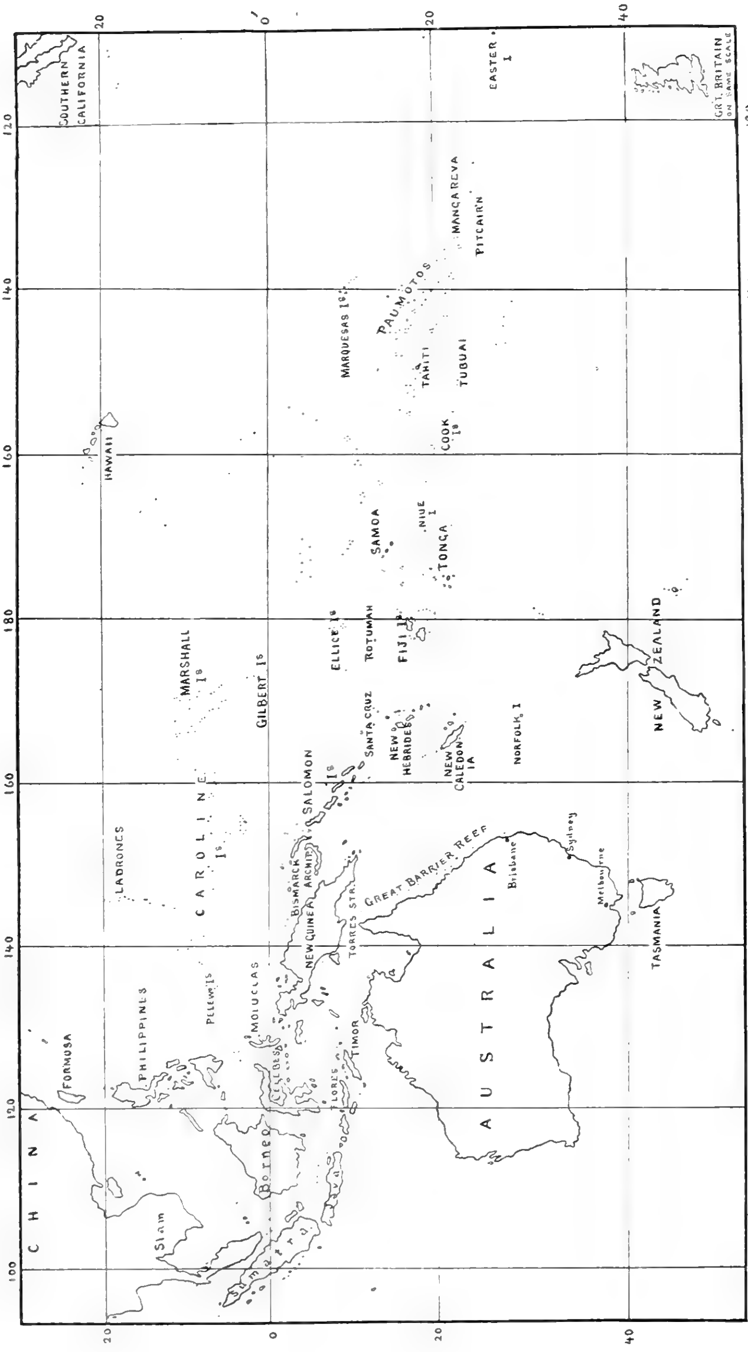
THE map of the mid-Pacific shows about eight hundred small islands dotting the expanse of the tropical sea. So prominent do these appear upon the chart with their names stretching over hundreds of miles that the voyager is surprised to find that they are in reality all but lost upon the vast area of the waters. Thus it was that in 1521 Magellan sailed 8,000 miles across the ocean and saw only four small uninhabited islets until he came upon the Ladrones in the far eastern Pacific.

During the century that elapsed after Magellan's voyage, only two important mid-Pacific groups, the Marquesas and the Paumotos, were discovered, for the explorers made the best speed they could with the southeast trade wind from the coast of South America, and such a course even from Cape Horn carries one to the northward of the great archipelagoes which lie in the tropical regions of the southern hemisphere.

Yet in the Pacific even in these days of steam, there stretches for days and weeks around one only the monotony of sea and sky, and it is with the delight of surprise that the far mountain peak is seen looming cloud-like through the haze, or, if the island be an atoll, a ragged row of cocoanut palms thrusts suddenly above the long line of the horizon.

Apart from such large land masses as New Caledonia and New Zealand, which contain continental rocks, the islands of the mid-tropical Pacific are either volcanoes, or elevated limestone reefs, or low-lying atolls which are believed to rest upon the submerged peaks of extinct volcanoes.

Sir John Murray tells us that the area of the Pacific is about 69,000,000 square miles, 65 per cent. of which is between 12,000 and 18,000 feet in depth. Indeed, the floor of the ocean between the Galapagos and the Paumotos is a plain in comparison with which the wide levels of Russia and of our Middle States are diversity itself. This vast flat bottom of the eastern Pacific is the widest area of deep water upon earth. Asia, Africa, and North and South America might all be sunken beneath it and not overlap. Indeed, one might sail nearly 8,000 miles southeastward from Behring Strait to the Antarctic, and for 7,000 miles of the course the least depth would be 12,000 feet, and at no place would the bottom be within a mile of the surface. The continental shores rise abruptly from this deep, floor, and in a few places we find trough-like or pit-like depressions sunken far below the bed of the sea, or an isolated volcanic cone rises dome-like from the plain, but the diversified



ISLANDS OF THE PACIFIC.

landscape of hill and valley has no counterpart in the hidden world beneath the sea.

The deepest regions of the oceans are commonly close to the shore and are believed to have been caused by the crumpling inward of the earth's crust due to the pressure of the near land. Such is the "Tuscarora Deep," a long narrow trough which extends northward from Japan along the coast of Asia; its bottom being more than 27,600 feet below the surface of the sea and 12,600 feet below the general level of the ocean's floor. An even more profound abyss is the Aldrich Deep close to the Tongan and Kermadec Islands which sinks to a depth of 30,930 feet. The greatest yet found, however, is the Swire Deep off Mindanao of the Philippines, this being 32,089 feet or 3,089 feet deeper than Mount Everest of the Himalayas is high.

However, one gains an idea of the rarity of such abyssal regions from the fact that of the 9,750 soundings that have been made and reported in water over 1,000 fathoms in depth, only 17 were greater than 4,000 and only 3 exceeded 5,000 fathoms in depth. The greatest recorded depth of the ocean is only 409 feet more than six miles.

By contrast with these troughs and pits, submerged plateaus rise gently above the general level of the ocean floor, and here and there and at rare intervals a mountain obtrudes above the submarine plain. All these isolated mountains are volcanoes and thus every truly oceanic island is but the summit of a pyramid thrown upward until its corroding peak may rise 13,800 feet above the sea as does Mauna Kea in Hawaii, or if now submerged, it may be capped by a thickness of several hundred feet of limestone and coral as in Bermuda.

The fairest islands in all the tropic world are those of Marquesas and Tahiti, where jagged sheets of basalt tower in grotesquely sculptured precipices thousands of feet above the soft lavas and tufas that the rains have washed away. Long ago these islands were volcanoes of an explosive type such as Ætna of to-day, and molten basalt welled upward from the depths and filled the gaping rents in the pyramids of softer ash and lava. Then, after the fires had died, the tropical rains began their slow persistent work so that to-day deep valleys wind sinuously downward from the summits to the sea, and the sound of rushing brooks is forever upon the ear. Green as corroding malachite set in the azure of the sea, the splendid peaks and shaded gorges lie mantled in the soft mist-loving verdure of the tropics, where the banana, orange, breadfruit, mango, kavika, alligator pear, and Tahitian chestnut grow in wild profusion.

The surf in these tropical regions is far less destructive than along our own frost-ravaged shores, for this is the domain of coral reefs, and many a crumbling volcanic cone lies protected within an encircling break water upon which the wave is smothered into foam, leaving only ripples to reach the palm-fringed shore.

Tae-o-hae Valley, Nukuhiva Island, Marquesas.

Sheltered thus from the wear of the sea, lies the slumbering volcano whose fires have been dead for many a thousand years. At night, the cool air of its mountain heights wafts downward to the sea, fragrant with jessmine and spice, and all the subtle perfume of a tropic wild. By day the sea-breeze assumes the mastery, and awakens the snowy flash of breakers where the rollers die into wavelets a mile or more from shore. This silvery line of surf marks the position of the barrier reef which encircles the island, leaving a calm and shallow channel between the reef-rim and the shore. Here protected the native plies his frail canoe, knowing as he does all the haunts of the fish among the coral clusters which here and there rise abruptly from the depths to the surface; and on calm days we may wade along the outer edge over many a place where a single seaward step would plunge one into water a hundred feet in depth.

Rich coral reefs usually occur in inaccessible places and are so studiously shunned by commercial vessels that the ordinary traveler has but little opportunity of seeing them at close range. The living corals rise in clusters above the volcanic rock or limestone upon which they have acquired an anchorage. They are, as is well known, animals closely related to sea-anemones, and their young when as small as a pin's head, are cast out into the water as little pear-shaped larvæ covered with vibrating cilia. After being drifted by currents and swimming feebly for a few days, the little creature settles down upon the bottom and soon grows

into a minute sea-anemone-like animal whose skin secretes lime and thus forms a skeleton, and it is this stony support, after the animal itself has died, that we commonly call "coral." After it has become attached to the bottom, the little polyp acquires tentacles which surround the mouth and then it begins to grow either into a simple form, or by budding to assume a shape in accordance with the habit of its species. At first but a single polyp it buds or divides so that there may be thousands of such with their stomachs more or less connected. Thus the animal is a colonial one, and when one polyp captures a minute crustacean, the other polyps in its neighborhood share in the benefit. Doctor T. Wayland Vaughan, who has studied them most carefully, tells us that corals are voracious creatures and feed upon almost any small floating animal they can capture, but plants they will have none of for they are strictly carnivorous.

Olive and yellow-greens, mauve and purple-browns are the colors of the living corals. Glinting they lie in the limpid water with the glistening white of limestone sands around them. Here and there accentuating the color of the scene is a deep blue starfish (*Linckia*), or a flower-like sea-anemone a foot or more in width beautifying a crevice with tracery rivaling old Venetian glass, while closely wedged within its special cavern lies the giant clam (*Tridacna*), the sinuous cleft between its valves, a zigzag of malachite and blue, green or mottled brown. Among the corals, one finds delicate forests of fused branches rich purple-brown with pink and snowy tips (*Acropora*), or green-olive and yellow-green nodular forms such as *Porites*, *Orbicella*, or *Goniastrea*. Some of

CANOES AND WARRIOR OF UOLA ISLAND, TRUK GROUP, CAROLINE ISLANDS.

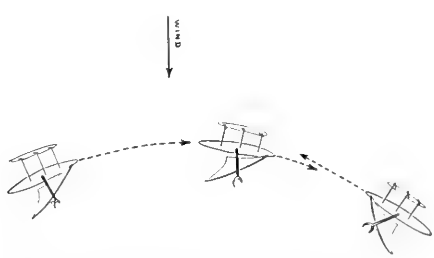
Sheets of Tapa being Bleached and Printed in Anticipation of the Wedding of a Chief. Tongatabu Island, Tonga.

the species of *Porites* upon the Great Barrier Reef of Australia are twenty or more feet in diameter and must surely have been a century in growing, for it is known that in Torres Straits under favorable conditions they may enlarge in diameter at the rate of nearly two inches per annum.

Silt and drifted mud are fatal to corals, for they stifle the feeding polyps and the dead surface is soon honeycombed by a host of worms and weeds and mollusks, so that the base of each old coral-head is cavernated with intricate retreats which form the home of the reef fish—those living jewels of the tropical sea, rivalling the butterflies in color.

Opposite the mouth of every mountain stream, we find an opening in the wall of the encircling reef; for the outflow of brackish water and silt prevent the growth of corals in such places and thus a harbor is formed. Here nestled under the shadows of palm trees close to the protected shore lie the thatched houses of the natives, resembling haystacks as one sees them from afar.

Drawn up in an irregular line, for all is hap-hazard in the South Seas, lie the canoes of the village, carved in strange symbolism to propitiate gods and tribal heroes. Each has its slender outrigger ingeniously constructed, a marvel of flexibility and strength, and its sail woven of pandanus leaves is carefully covered under a matting to protect it from the molding due to damp. In sailing, the outrigger is always on the windward side, and the sail itself is never reefed, but instead one, two or three men place themselves upon the outrigger. Breezes are known therefore as "one," "two," or "three-man winds." A high degree of skill is required in sailing these canoes, for the outrigger must skim lightly through the water. Should it rise into the air, the canoe over-



MODE OF TACKING AN OUTRIGGER CANOE.

turns, and if it sinks, a sudden luff capsizes the navigators; not, however, a serious accident where all are swimmers from earliest childhood. As the outrigger must always remain upon the weather side the method of tacking is curious, for instead of luffing up into the wind, they put the helm up and hold the canoe off until the wind is abaft. Then the "tack" or lower point of the lateen sail is carried aft and tied down; and the canoe starts backward, that which was the stern now becoming the bow.

HOUSE AT EUA ISLAND, TONGA, showing a wooden drum and drumstick in the foreground.

Such is the life of man upon the "high islands" of the tropical Pacific, and as for the islands themselves, the fascination of their isolation is the keynote of their charm, set as they are in the amethystine blue of the coral sea that flashes into emerald over shallows near the shore.

THE COUNCIL HOUSE, FUNAFUTI ATOLL, ELLICE ISLANDS.

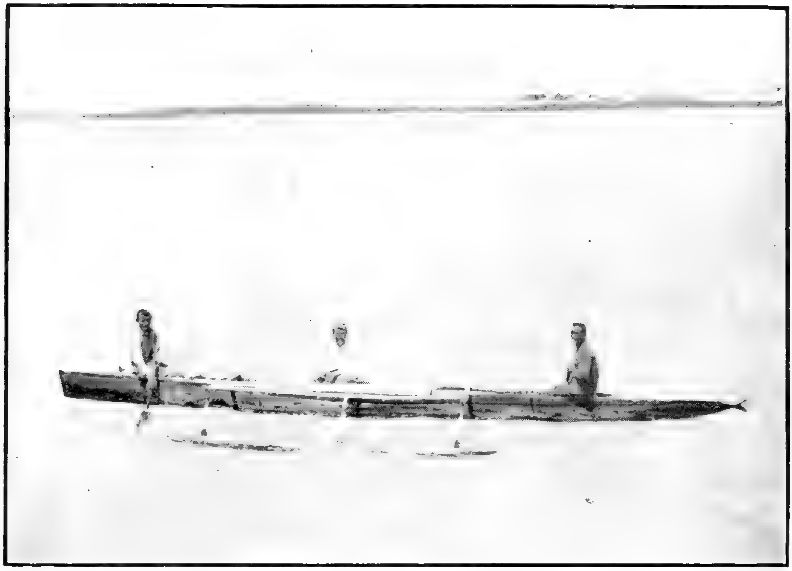
Forests rich with fruit, and many a stream and coral reef afford sustenance in abundance to the natives of these favoured regions of the tropical Pacific.

But there is another, much commoner, and wholly different type of island—the atoll. The popular idea that atolls are circular or regularly elliptical in outline is false, for they commonly consist of a straggling line of long, low islets enclosing with many breaks an irregularly-shaped basin, or lagoon, the bottom of which is quite level and about one hun-

A House of Funafuti, Ellice Islands.

dred feet in depth, although often many miles in width. Another erroneous impression is that the islets are composed mainly of coral. Broken fragments of corals are cast upon their shores, it is true, and may form an irregular wall twelve or more feet in height along the seaward beach, but usually the bulk of the material forming the islets is composed of fragments of shells, calcareous plants, and other organic limestones which after being churned and pounded in the surf are finally tossed up by wave and wind, above the reach of the sea.

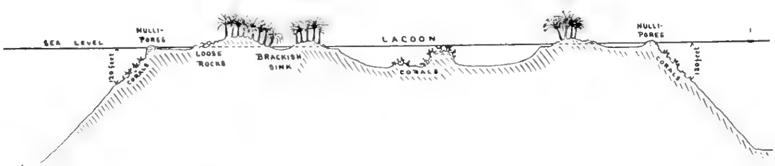
Darwin thought that atolls owed their formation to subsidence. He imagined a coral reef encircling a volcanic cone. Then should the volcano slowly sink beneath the sea, the ring of coral would as constantly grow upward until finally the central mountain would disappear leaving only the ring of the coral reef. Simple as this hypothesis appears upon paper, it does not accord with the observed facts, for it



THE FISH-TAILED CANOE OF FUNAFUTI ATOLL, ELLICE ISLANDS.

fails to explain the remarkable flatness of the bottom of the lagoon with its prevalant uniform depth of 20 fathoms.

The general seaward slope of the atoll is nearly 45°, so that one commonly finds a depth of three quarters of a mile within a mile from shore. Only the upper part of this slope is, however, covered with living reef-corals and these form a mere veneer between depths of 120 feet and the surface. Indeed, the upper rim of the reef is apt to project as a low ridge several inches above high tide. This ridge is dull red in color, and consists in a dense growth of stony sea-weed, *Lithothammion,* and nullipore.



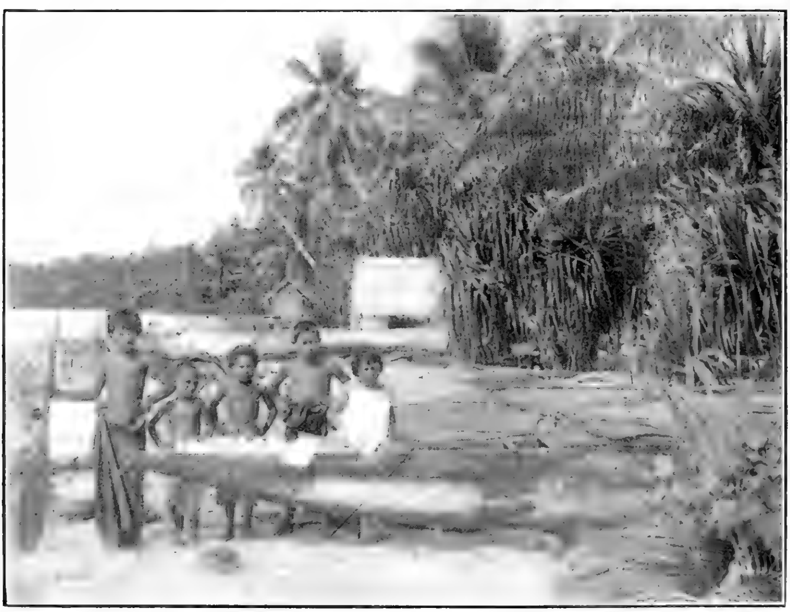
DIAGRAMMATIC SECTION OF A TYPICAL PACIFIC ATOLL.

Between the nullipore ridge and the shore there is a submerged platform over which the breakers drive so fiercely during storms that few corals can cling within its scanty crevices. This platform is usually from one hundred to six hundred feet wide and its floor is commonly not more than three feet in depth at low tide. The seaward beach of the island is a chaotic mass of dead and broken coral-heads which have

been torn from the outer reef and driven inward over the platform to be cast high above the wash of ordinary waves. On the lagoon side, also, we sometimes find the same conditions repeated upon a miniature scale; the slope, the platform, and the wave-raised coral-heads being similar to the corresponding formations of the seaward side of the islet, but the nullipore rim is commonly absent from the lagoon side for these limestone-making plants thrive only in heavy breakers.

In the center between the seaward and lagoon-ward ridges, one finds the lowest part of the islet, this region often being below sea level, and forming a brackish swamp, whose noxious waters constitute the only drinking supply of the atoll.

Brain corals and other huge, massive forms grow close to the seaward edge of the reef, where the surges dash over and among them, but the forests of fragile stag-horns (*Acropora*) thrive best in more protected places. Others called the *Fungiidæ* are attached, only in early life, by a slender stalk which soon breaks, and they then lie loosely upon the reef like petrified mushrooms pushed about at the caprice of the waves. Others (*Siderastrea*), called "rolling stone corals," may break loose and be rolled about, the upper side always regenerating and growing so that the mass becomes egg-shaped or spherical. In general, however, as has been shown by Vaughan and others, the small branching and slender forms must grow either at considerable depths or in protected places to withstand the rough treatment of the sea, thus the deep parts of the seaward precipices of the coral reef are



A CANOE UPON THE LAGOON BEACH OF FUNAFUTI ATOLL, ELLICE ISLANDS.

A Belle of Funafuti, Ellice Islands.

covered with fragile corals, *Oculina,* and *Eusmilia,* and the leaf-like *Turbinaria* and *Agaricea* secure in their quiet depths beneath the agitation of the storm.

Reef corals do not commonly grow, however, at depths greater than 100 feet, and indeed the most flourishing are in water less than six feet deep, and some are even laid bare at the lowest tides. In times of hurricanes vast masses of broken coral are caught in the rush of the waters and tossed far up upon the outer edges of the reef flats, and rocks weighing tons may thus be lifted fully fifteen feet above the level of

the sea. In this manner the originally submerged rim of the reef has in some places gradually been raised, new corals growing upon the shattered fragments of the old, but we must always remember that the slow persistent effects of everyday conditions have far more to do with shaping atolls than have hurricanes.

In coral reef regions, the bottom of the sea is often found to be covered with fine white limestone mud. This becomes converted into rock and may form plateaus thousands of square miles in area and hundreds of feet thick as in the Bahamas and in Florida. This chalky deposit was formerly called "coral mud," but recently, Drew and Kellerman have shown that it has no relation to corals, for according to these authors the warm surface waters of the tropical ocean are infested with bacilli which set up a complicated chemical reaction that enables the calcium to combine with the dissolved carbon dioxide and to form a chalky precipitate, the myriad little granules of which may possibly cause the wonderful blue color of the tropical sea. In any event, in the Atlantic this precipitate sinks to the bottom and there forms into oolite in the manner described by Linck and by Vaughan.

It may be of interest to observe that the relative paucity of nitrogen in the waters of the tropics may account for the few seaweeds found in warm regions, for nowhere in the tropics are there anything like the kelps and fucus that cover the rocks of the north Atlantic shores of Europe and America. Also the scarcity of plant life in the tropical ocean is correlated with the comparative absence of the swarms of floating marine animals such as are so characteristic of Arctic seas, for in cold seas individuals are abundant, but species are few, whereas in the tropics there are many species, but most of them are rare.

In the tropics, where frost is unknown, the moist shell-sand of the beaches is dissolved by rain water and then precipitated, the fragments becoming cemented into a solid rock-mass, this action being especially noticeable between tidal levels, but by no means confined to such places, for in the Bahamas hills several hundred feet high have been formed in this manner out of wind-blown shell-dust and limestone particles. Indeed, rain water charged with carbonic acid derived from the decomposition of vegetation dissolves limestone and thus each little grain of shell-sand is partially dissolved, and then, if the water evaporates or the limestone be precipitated, the grains become cemented one to another by little bridges of calcium carbonate, and thus a *Coquina* is formed, such as one may see at St. Augustine in Florida, and on most of the atoll islands of the world.

Currents, waves, and winds have much to do with the building up of the islets of the atolls. The waves press constantly over the rim, and the basin of the lagoon is filled to overflowing, so that most of the water thus driven into it must escape on the leeward side. According-

CANOE DRAWN UP UPON THE BEACH AT RONGELAB ATOLL, MARSHALL ISLANDS. The sail is covered with a thatch of pandanus leaves to protect it from rain. The little deck-house on the outrigger is for storing food when voyaging.

ingly, the deepest openings are always so placed that we must beat up into the wind in attempting to enter the lagoon. Practically every deep entrance into a Pacific lagoon is partially blocked on the inner side by an islet which has formed in the vortex from materials drawn together by the outrushing water.

Even when the tide is high, there is apt to be an outflow of water through all openings on the leeward side of the atoll, but at low tide the whirlpools and breakers in such places are often fearful to behold.

In opposition to Darwin's theory, an hypothesis, prominently presented by Professor Reginald A. Daly, is gaining ground. This states that the great polar ice-caps of the glacial period must have been formed from water taken up from the ocean by evaporation to constitute the snows of the polar regions. Thus the level of the trop-

ical oceans of those days may have become about 120 feet lower than at present. Now, if this were the case, the sea would wash away the shores, forming platforms at sea level for the corals being mainly killed by the low temperature could not protect the Island from the waves. Then, when the ice-caps melted and the ocean rose and again grew warm the corals growing upon the outer edges of these platforms formed the present atolls and barrier reefs. If this be true, all the modern coral reefs are upon platforms which the corals themselves did not build up, but upon which they merely grew after the glacial epoch. In confirmation of this, Andrews has shown that the platform upon the seaward edge of which the barrier reefs of Australia have grown, extends southward beyond the latitude of coral growth. We may observe that it also extends northward to New Guinea, beyond the region where the corals are killed by the silt from the Fly River. Dr. Vaughan has also demonstrated that the platform upon which the Florida reef has grown extends northward from Fowey Rocks into a region too cold for corals, and he shows that this relation appears to be general among coral reefs.

As one approaches the atoll presents a charming picture. At first only a line of cocoanut palms seemingly arising out of the ocean itself. Then the white glint of sandy beach and, finally, we sail through a narrow opening and find ourselves securely anchored in the limpid

SEA-GOING WAR-CANOE OF UOLA ISLAND, TRUK GROUP, CAROLINE ISLANDS. Canoe 25 feet long.

PRIMEVAL FOREST OF QUEENSLAND, NEAR KURANDA.

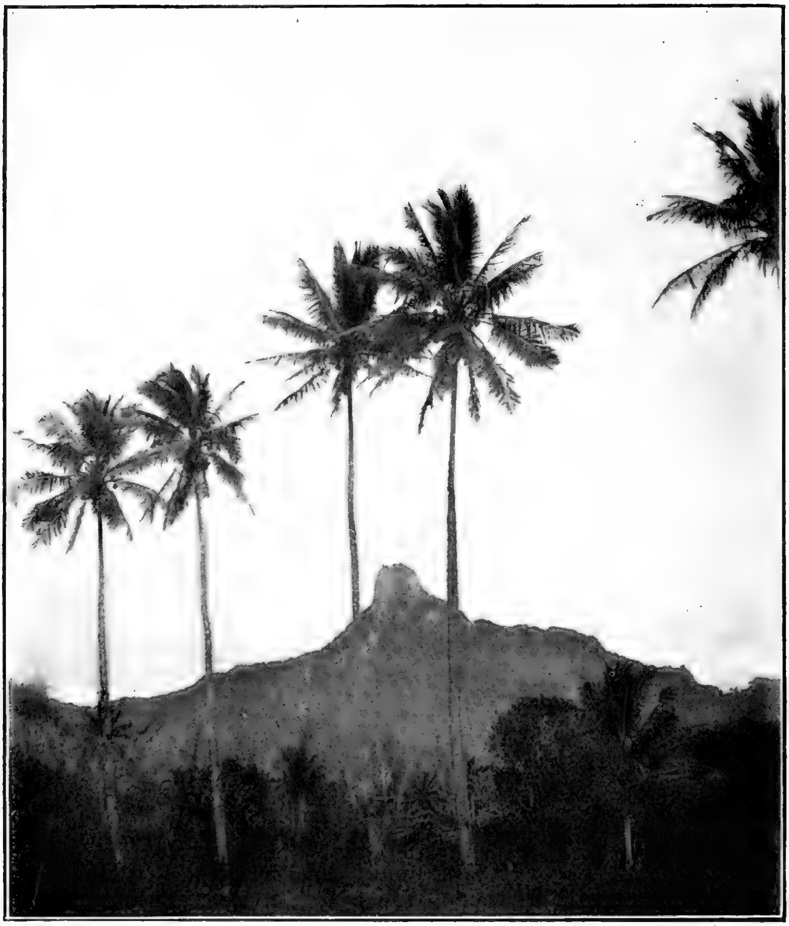
waters of the calm lagoon surrounded by a narrow broken ring of islets.

Glistening and brilliant it lies with the sunlit sea around it, a shimmer of turquoise and emerald set in the everlasting blue of the Pacific where the flash of flying spray gives action to the scene. With its palm groves bending to the breeze, its alabaster beach, and by contrast the soft colors of withered thatch where palm-leaf houses nestle beneath the shade along the lagoon's shore. All splendid and sparkling, none can resist the invitation of its charm.

But once on land, one is doomed to disappointment. The natives

Barron Falls, Queensland, Australia, in the Dry Season. These falls are about 700 feet high.

are starved and sickly in comparison with their more favored cousins of the high islands. The scintillating heat of the blistering sands, the sparse and thorny plants of less than fifty kinds, redeemed only by the cocoanut and the pandanus, without which man must starve or die of thirst—all illusions vanish in the stifle of the barren, glaring, thorny place and we long for the ship's cool deck and the awning's gracious shade. Life is poor and dull upon these atolls, rarely more than an



COCOANUTS AND OLD VOLCANOES OF RARATONGA, COOK ISLANDS.

eighth of a mile wide, with neither hills nor valleys, without streams or springs, and with the heavy murmur of breakers forever in one's ears.

Pure drinking water is the most prized luxury of the atoll. To obtain it, the natives cut furrows extending diagonally down the stems of cocoanut palms and leading into a cavity cut in the trunk of the tree, within which a few ounces may collect. Failing of this meagre supply, they resort in time of drought to the mosquito haunted swamps which occur here and there in the center of the islet.

Thus it is that the natives of the atolls are less cultured, less interesting and poorer both in material and intellectual things than are their relatives upon the high volcanic islands.

An intermediate geological condition is seen in another type of island which the non-geological traveler is apt to confuse with the volcanic, but which is actually only an elevated atoll or coral reef. In vol-

canic regions, considerable local oscillations of level are common and it is known that between the fifth and the twelfth centuries long stretches of the shore of the Bay of Naples sank forty feet beneath the sea and then rose 20 feet above its lowest level. In the Pacific greater oscillations have occurred, for some of the coral reefs of the Fijis are now more than eight hundred feet above the ocean, and other examples of elevated atolls or coral reefs are found in Niue, Eua and Vavau in Tonga, and in Makatea of the Paumotos islands.

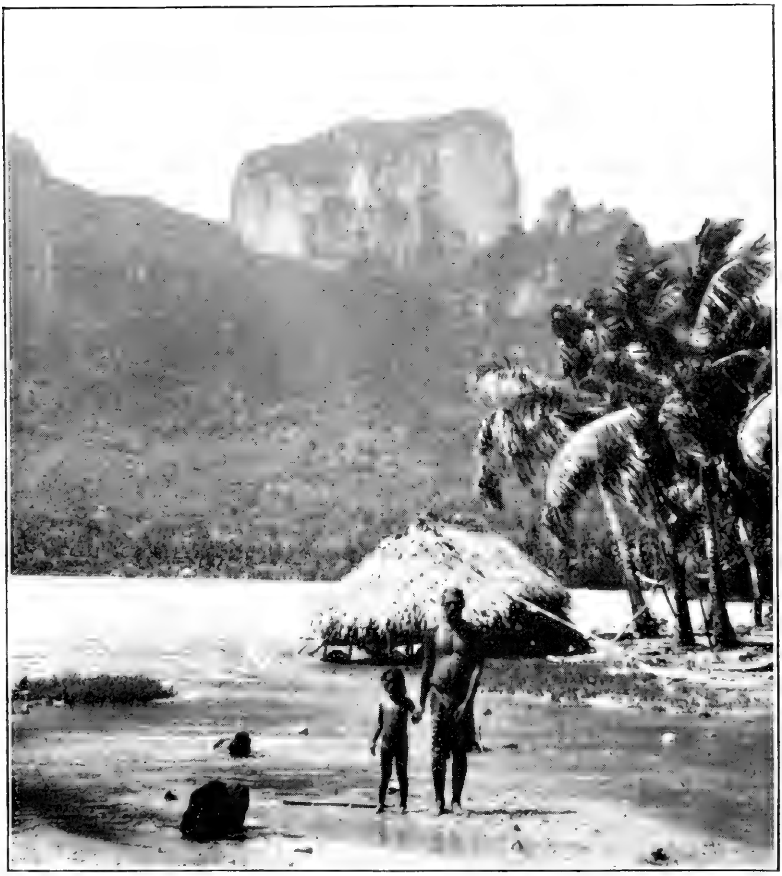
In these elevated coral islands, bold precipices of dull gray limestone frown gloomily upon the sea, their hostile walls stained here and there a rusty red where coral heads have decomposed, leaving the ruddy stain of iron. Caverns with stalactytes drooping like curtains from their roofs are found along the steep face of the cliff, and within them the chiefs of other days lie buried. In places the sea gains access to these caverns, and in the darkened pools live some of the creatures whose true home is upon the dimly-lighted bottom of the sea, 1,000 feet below the surface. Yet here in the everlasting shade flower-like crinoids crawl slowly over the rocks, and long, lythe sea-whips (*Alcyonaria*) coil and uncoil in the dying surge that wanders to their far retreats.

The torrential rains of the tropics have for ages been beating down upon these elevated coral islands so that the whole surface is a riot of jagged projections. If flames were by a magician's wand suddenly turned to rock, they would not be more grotesque or flaring than these knife-edged masses which everywhere project over the surface of an elevated coral island. Here and there and everywhere the mouths of treacherous caverns yawn to entrap the traveler. So clinker-like is this barren rock which rings with a metallic sound when struck, that the non-geologist at once concludes that the island is volcanic, and only the sight of corals heads imbedded here and there in the scoriaceous-looking mass will convince him that he is treading upon an elevated reef. One's boots are torn to shreds, yet the bare-footed natives leap from crag to crag uninjured; a marvellous example of the superiority of natural shoe-leather.

The soil of these islands collects in the numerous crevices, and here the banana grows in the dark-red ferruginous earth that gathers in the bottom of many a pit. Thus the older these islands, the deeper does their soil become, so that at Namuka, Vavau, or Eua in Tonga, or in Niue, we find the surface covered with a rich rusty soil which supports a vegetation almost as varied as that of the volcanic islands.

Only half conscious of the present, wantonly forgetful of the past and heedless of the future, life in the south seas passes as a day-dream, a reverie aimless as the airs that trifle among the palm leaves only to lapse into the nothingness of things that were. Yet nature in the

tropics is a trixy jade, and at times drops her seductive, soothing ways and rushes headlong into tragedy. All other memories may lapse into forgetfulness, but the day and year of the hurricane is recalled, and the story of it passes into myth and is handed down from generation to generation.



THE BASALTIC PEAK OF BORA BORA, SOCIETY ISLANDS, showing the trade wind in the palm trees.

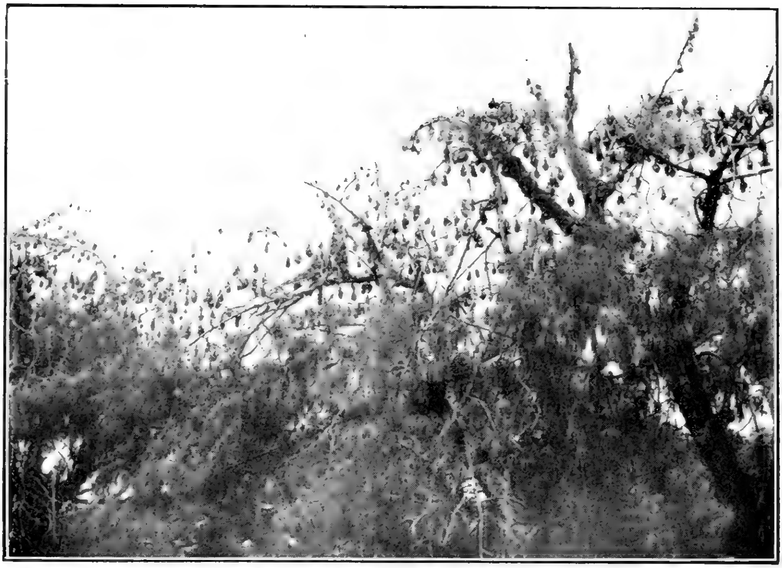
Hurricanes come in the autumn; in that season when the long, hot calms of the tropical summer are about to break into the steady trade winds of the winter months. Thus in September and October in the West Indies, and in February and March in the South Pacific, the heated air rising above the sea is believed to set up an inrush from all sides and a great whirlwind gathers, aided probably by the close proximity of the developing trade winds, and by the rotation of the earth, for the swirl is always contra-clockwise in the northern and clockwise in the southern hemisphere, while the storm as a whole

Native Huts at Jaluit, Marshall Islands.

drifts with the currents of the upper air in a curving course to westward and then away from the equator.

The hurricane of fiction is always preceded by an ominous brooding calm with a sky of sickly green against which palm leaves stand out

Canoe Laden with Materials for Constructing a House, Fiji Islands.



SACRED BATS OF HIHIFA VILLAGE, TONGATABU.

like spikes of copper, but in reality the great storm is usually ushered in by gales which increase in violence until they break into a riotous tumult.

COCOANUT PALMS. LAGOON BEACH OF FAKARAVA ATOLL, PAUMOTOS. Robert Louis Stevenson lived within this grove.

The very air becomes an entity, a thing real as the rush of water, overwhelming all in its path. A roar, unearthly in its might, rises at intervals into wild shrieks that overwhelm one's voice. The solid rain drives horizontally and buildings leak more through their sides than through their roofs. The crests of waves are blown far and away, and the sea flattens under the crushing pressure of the storm, the dark waters hidden beneath a white sheet, gray swirls scudding ghost-like over all. The wind comes, not straight, but in fearful twisting swirls and bits of seaweed strike against lighthouse windows one hundred and sixty feet above the sea. One stifles. The air, no longer a pellucid nothingness, has become an enemy against which one can

House at Papara, Tahiti.

not stand; above which one can not shout, and, in the mighty presence of which, man is an ant-like thing, his smug assumption of mastery over nature a ridiculous pretence. There is no protection anywhere, even the strongest, highest wall serves but to create a maelstrom behind it.

The trunks of stately palms bend humbly to the onrush until they thrash upon the ground, or tearing loose fly upward into the vapor of the storm. Great trees fall, but one hears no crash; houses change in shape and crumble and there is no noise from them, for all sounds of earth are as silence in the presence of the vast voice of the air.

Then, after hours that seem as years, as if all nature had fallen

into war and peace could never come again, the wind unexpectedly ceases and the demon of the storm smiles down upon a blighted world. A candle flame may live in the sullen air, yet all around the horizon lies the black wall of the hurricane glistening in silver where it presses on the sea, and a confusion of huge waves come toppling in from all directions, crashing one against the other, and the barometer sinks to its lowest level. Afar off, one hears again the dull roar, then onward it comes with sudden fury, but reversed in direction, to finish the work of destruction it had but half accomplished.

After all is over the sun—the long-forgotten sun—shines out upon a land, hideous in its ruin. The forest lies in shattered skeletons and dangling here and there are blackened rag-like things that once were leaves. The houses of the village lie shapeless, strewn among the common wreckage of the palms where the great waves let them lie, and strange rocks weighing tons have risen from the sea as monuments to the reality of nature's awakening in a region where once she seemed but to dream and soothe with gentle airs and flirt with all things real.[1]

Yet tropical nature knows no mourning and laughs at death and ruin. New life seizes covetously the lost places of the old and in a few years only the trained eye of the native can detect traces of the work of the great hurricane.

Once or twice in every generation each island is devastated by such a storm. Yet so wanton is tropic life, so heedless, listless and resigned to things that are, that nowhere in the South Seas have the natives taken the trouble to construct hurricane-proof refuge houses into which the village might retreat in time of need.

[1] Such a rock is to be seen upon the reef-flat of Lottin Harbor, Kusaic Island in the Carolines. It is 15 feet long, 8 feet wide and 8 feet high.

THE RACES OF BRITAIN

By WM. H. BABCOCK

WASHINGTON, D. C.

NOW that several great world powers are engaged—among other things—in violently rearranging the map of Europe, perhaps more nearly on ethnological lines, we may profitably consider the racial composition of those powers themselves. Not the least of them is the wide-flung British Empire, having its center of life in the ancient island of Great Britain. We must also touch upon her companion Ireland, for they have acted and reacted on each other by partial conquest and peaceful immigration since before the dawn of history.

British ethnology has an especial appeal to Americans, since what was true of the one country in such matters was very nearly true of the other at the time of the revolution and separation. Of course, all the elements of the British islands were more perfectly fused here than there, since, even in rural England, Dr. Beddoe points out many streaks and patches of population of different and even contrasted appearance; also the Indians had added something; and we all know that there were many Dutch in New York, many French creoles in the southwest and divers other accessions of less bulk from various quarters; but even long afterward De Tocqueville—a keen and philosophical observer—could still define Americans as that branch of the English people to whom a special work had been assigned, evidently with no thought of any essential divergency. Since then we have had a great flood of unequally distributed immigration, which has repeatedly changed its source and quality; but it has left extensive areas comparatively unaffected, and, in part, it has been assimilated in other areas, often with little obvious change in the assimilating body. Of that great assimilating and determining body of American people we may still say that in language, blood, customs, laws and aspirations it is more akin to Great Britain than often happens in the case of two great independent nations. Indeed, I do not recall any instance of equal similarity on a large scale.

Language is of course an uncertain guide as to race, but it is often a clue and always significant, always a surviving record of history, lost or remembered. Now, Great Britain is conspicuously an island of three languages, not mere dialects, but completely organized, historic, distinct developments of human speech. All are of the Aryan family of languages, two belonging to the Celtic group of that family, the third to the Teutonic group and its Low-German subdivision, which includes also Dutch and Flemish. These three languages of Great

Britain are English, occupying exclusively by far the greater part of the island; Welsh, a modern remnant of old British, spoken still in the western mountains; and Gaelic, spoken in the northern mountains of Scotland, also, far west of the Welsh, in parts of Ireland and in some intervening islands. As might be guessed, these three languages are relics and records of three great waves of invasion and conquest, with intervals of several centuries between them.

Another interesting fact is the permanency of the situation above outlined, which is not substantially different to-day from what it was in the sixth century when Gildas wrote. The Saxons were then in possession of all the eastern part of England, excepting some isolated fastnesses; the Britons were west of them in the mountain country and the tracts just above and below it; the Gael were beyond in Ireland, probably also on the seaward side of the British territory; also far north in the Highlands. It will be seen that the greatest difference is in the spread of the intrusive Anglo Saxon (now English) speech, accompanied by a like displacement of race, on a great scale, though much less in degree: but these do not affect radically the general map arrangement of tongues and peoples—then newly, but perhaps finally, accomplished. There have been other great invasions and long-continued occupations of Great Britain since then—the Danish, the Norman—as there had been one before in historic times, the Roman; but none of these changed the speech of any part of Britain, except by supplying a few words for our present English vocabulary. Their changes of population, though real, are either matters of debate and uncertainty, or have dwindled, as in the case of the Danes, with the lapse of time, and in no instance present a solid mass of men so sharply marked off from their neighbors as the Welsh or the northern Gael. It is well, therefore, to bear in mind this division into three parts, English, Welsh and Gaelic, as the most conspicuous fact of Great Britain's racial and linguistic history for the last 1,400 years.

The Angles, the Saxons and cooperating tribes came chiefly, as we know, in the fifth and sixth centuries of the Christian era; the Britons and the Gael much earlier, though the exact periods are sufficiently uncertain. Whatever the dates, these were three successive waves of blond people, no doubt including some darker elements and differing from each other more or less in kind and degree of blondness, but such as we might expect to leave a predominantly light-tinted and light-haired population in Great Britain as the total result of their successive blond overflowings—if there were no counterbalancing influence that was even more important.

There certainly seems to be such an influence; for there are more dark or medium-tinted people in Britain than the positive blonds of all kinds taken together; and almost everywhere, perhaps everywhere,

the darker people are gaining in numbers on their lighter kinfolk. These facts can not be adequately accounted for by later dark immigration. Such undoubtedly occurred and indeed has not ceased even yet, but would be offset in great measure by blond immigrants other than those above mentioned. The most natural and now generally accepted explanation is that the Gael (or the first Celtic-speaking invaders) found before them a darker population, which was more numerous and also better fitted to survive and perpetuate its characteristics by reason of long occupancy and acclimatization. There can be little doubt as to the first item and surely none at all as to the second, at least so far as concerns some of the elements of those pre-Celtic people; for it is quite obvious that they would comprise the residua of all previous conquests and immigrations, except of course such temporary visitors as may have gone away again, leaving none behind, and such feeble folk as may have been utterly exterminated. Only the latter process could remove those who had penetrated far beyond the shore, and it is hardly credible in any instance in so extensive a region abundantly provided with places of refuge. In truth, the complete extirpation or removal of a race is an unknown, or excessively rare, thing in human history.

It would be important and interesting to consider the composition of this pre-Celtic population, if we had sufficient reliable materials to go upon, but, as matters stand, it will be better to content ourselves with a very brief superficial glance at the successive human waves which had reached Britain. Perhaps the earliest comers walked there, while as yet the waters had not come through the English channel nor spread out to form the North Sea. It is said that some of the earliest relics of quite certainly human anatomy and human handiwork in all the world have been found in very recent years in the low southeastern counties of Britain, which were the regions naturally first entered, and most abundantly peopled, by nearly all later comers so far as we know. To reach the period, we must count our years back by many scores of thousands, some have guessed a quarter of a million more or less. Naturally, these people were rudimentary in every way and we are always at some risk of mistaking the random stone-splinter work of nature for such poor beginnings of human tools as they have left. They must have existed among dangerous creatures and alarming natural forces by a combination of good luck and negligent sufferance, helped out by a barely human craft and embryonic industry. From that time on, through the enormous stretch of the paleolithic horizons, we may picture mankind in Britain as a grotesque procession, trampling up out of its grotesquerie, improving in bodies and in tools from age to age, though disturbed by sudden irruptions from distant regions. Some have thought that certain types of man, long conspicuous in early Britain, came from the far east, others from the hot south now known

as Africa. It can not be said that there is a regular succession of improvement in race in Europe anywhere; for some of the early types were quite respectable in their development of brain and body, while others have an abnormal and portentous look. In some instances divers anthropologists have ranked them as of different species from our own, though still quite human. What is true of Europe generally must in the main be true of Britain, although the evidence from its less ample and more remote area is naturally less abundant and complete. It seems more than likely that two or more of these very different kinds of men, of quite diverse attainments, though in no case of a very high order, would often be found in Great Britain at the same time. Perhaps few of them would correspond at all closely to any variety of man that we know until the latter part of the paleolithic age, an enormous reach of time having many stages.

There is a little evidence, perhaps not quite convincing, of strange survivals even until now. Thus Dr. Beddoe writes in his Races of Britain:

> I think some reason can be shown for suspecting the existence of traces of some Mongoloid race in the modern population of Wales and the west of England. I have notes of 34 persons with oblique eyes, the iris is usually hazel or brown and their hair straight, dark brown, black or reddish. This type seems to be common in Wales in West Somerset and especially in Cornwall.

He has found no such instance from the east of England and "very few from Ireland," but adds:

> I believe that specimens of it might easily be found in the mountainous parts of Connaught, especially on the borders of Sligo and Roscommon.

Again he says:

> There is an Irish type which I am disposed to derive from the race of Cro Magnon. In the west of Ireland I have frequently seen it. It is said to be common in the Hebrides.

He cites an article of Hector McLean on this and adds:

> Though the head is large the intelligence is low and there is a great deal of cunning and suspicion.

He refers also to prognathous specimens, a type often overlapping with the Mongoloid, but different, as being common in Dorset and Devon, especially toward Exmoor. He says its characteristics can not have been caused by oppression and misery, the conditions being otherwise and the average height of thirty-four of these people being five feet seven inches. He mentions also finding this type in the rougher parts of Ireland and says:

> While Ireland is apparently its present center, most of its lineaments are such as lead us to think of Africa as its birth place. I believe this Africanoid type to be of high antiquity.

The paleolithic people, like nearly all later occupants, seem to have left their underground relics most plentifully in the extreme south and southeast of Great Britain. Like most others too, all varieties of them would be successively driven to the forests and mountains or even across the water to Ireland (if they could get there), and in the last resort to the wildest nooks of that island also. It will be noted that those are the very parts of both islands where Dr. Beddoe thinks he still discovers some traces of them in living men and women. But the paleolithic population at all periods and of every kind must have been scanty, for hunting and fishing will not support many people and there is no reason to suppose that they had other resources. In the rugged regions where they found refuge they would never greatly increase. Consequently their practical influence on the inhabitants of the richer parts of both islands must have been very near zero for thousands of years. So there need be no particular concern as to the finding of some supposed Negroid, Mongolian or other characteristics, alien to the white race, in individuals of sequestered mountain and moorland communities.

There is another sort of evidence, which Dr. Mac Ritchie has collected rather abundantly from tradition in a very interesting work on Ancient Britain, going to show that there were quite wild and dangerous savages, apparently remnants of some early race, running at large in the highlands of Scotland in periods very much later than that with which we deal. It will be remembered that there were similar legends, in even more exaggerated form, of prodigious folk, in the southwestern British moors and along the rougher part of the sea border. These giant-tales may preserve nothing real, but again they may record a racial memory on the part of later and more civilized occupants of those who never become inured to quiet ways, but long continued to exist in forest and mountain recesses. They seem to have nothing in common with the next occupants of the land.

So far as we can judge, the paleolithic people of whatever kind were overwhelmed by a relatively great influx of neolithic people, who were pastoral, agricultural, better organized and more advanced in every way —possibly ten, fifteen or twenty thousand years ago: it is not a matter as to which we can set dates. Sometimes they are called Picts, a name which lives both in legend and history and no doubt has sometimes been applied rather loosely to their various allies also, or to people confused with them. In Ireland the name fir-bollig was also applied to a great body of people who long continued to resist the conquering Milesian Gael. Doubtless they too included heterogeneous elements; but the dominant pre-Gaelic and pre-British type seems to have been on the whole the same; and to be abundantly commemorated by the long heads and dark hair of the majority of the people in both islands, characteris-

tics which belong also to what is sometimes known as the Mediterranean or Iberian race of southern Europe.

Compared with some earlier and later occupants of England, they present a gracious and winning, if not powerful, aspect. As shown by their long barrows or grave mounds, which were often provided with a stone chamber, accessible by a stone-walled passage, they were fairly tall (about five feet five or five feet six), rather slender, though not always, mild of feature, having fine small jaws, long-headed with good brain capacity and undoubtedly dark, resembling the long-headed inhabitants of Gaul. They knew nothing of any metal except gold, unless in their later stages. Yet they were able to produce so impressive a monument of industry as Stonehenge, with its great monoliths brought from a distance and neatly worked in the below-ground parts as well as those that are above ground—a feat quite impossible to any but a large settled and organized population, feeling the need of religious and political centers. Notable defensive works have also been ascribed to them; and some have supposed that the druidic system originated with them and passed on later to their successors, the Gael and Brython.

There seems no conclusive evidence of intermarriage with their predecessors; perhaps the difference in methods of living would prevent this, except in rare instances, also the sparseness of the earlier hunting population, already alluded to. There is some slight evidence of heterogeneity in their anatomy, and the burial customs differed in various regions; thus the long barrows of southwestern England contain cremated bodies; those of Yorkshire, bodies buried intact after our fashion; whereas in northwestern Scotland they are about equally divided between the two methods. But, with slight qualifications, the evidence throughout Britain seems to indicate one fairly homogeneous race, at least in the more open parts, where the barrows are generally found; and there is no great reason to doubt its general prevalency.

Much discussion has always occurred, since men interested themselves in such matters, over the Pictish language as spoken in Scotland, some fragments of which have come down to us, mainly in lists of names and inscriptions, sometimes variously interpreted or beyond interpretation. Dr. Skene and others have considered it an archaic form of Celtic; but Sir John Rhys believes it to have been originally non-Celtic and even non-Aryan, though so deeply overlaid with Celtic accretions that it has often been mistaken for a variety of Gaelic or a variety of British—as he would say of Gaulish, meaning the same thing. Elsewhere he has pointed to other slight survivals of pre-Celtic speech, notably in the first syllable of Islay, often recurring in other combinations, and divers place names all over the island which are not to be explained by any known Celtic or post-Celtic language.

After the Picts or Fir-bollig or whatever we should call them, came

at a long interval a tall race of people provided with bronze swords and spears and no doubt instructed in arts of war, perhaps also of peace, beyond their predecessors and victims. Evidently the slighter forms and especially the primitive stone weapons opposed to them, were doomed to the complete subjugation that certainly followed; although there are indications that in some regions this was delayed—remote natural fastnesses where the beaten race was packed in great numbers and held together after sufficient time had elapsed for it to acquire and become familiar with the appliances of the aggressors. But the almost complete vanishing of every intelligible remnant of the speech of the conquered people is sufficient proof that this conquest was exceptionally sweeping, thorough and unyielding.

Probably the Gael were the chief builders of the round barrows which succeeded the long barrows, as the Celtic tongue succeeded whatever was spoken before; but now we find, as we did not find in the former instance, two types of skull, the long and broad, sometimes intermixed, which is taken to show a very early partial blending; this being more likely to occur where a numerous and sedentary population was overcome and partially enslaved. Those round barrow interments were usually, it seems, of the ashes and larger bones only, cremation having taken place at some other point: but the skulls have generally remained intact, and Dr. Rolleston, who examined many of them, collected by Mr. Greenwell, declares that these bronze-age mounds have the two types of skull in about equal proportion, whereas the skulls of the pre-bronze age mounds are all long. So it seems that in the bronze period the skulls of Britain, after a great intrusion of broad headedness, were already conspicuously on the way to become, as now, chiefly long headed again. This was in spite of an additional, but relatively small, independent intrusion of dark broad heads, perhaps from across the North Sea, a type which Dr. Beddoe finds here and there in Scotland, for example, in Fife and East Lothian. But there seems no reason to doubt that the round barrows of Britain were principally the work of bronze-using Celts, and especially of the Gael; and that these were blond, large-limbed people of strong, formidable, aggressive features and some proficiency in decorative arts, metal-working and whatever pertains to success in war. It may be that their really best work was done after they had settled down in the British islands. In their later period at least, their women could spin and weave well and their soldiers went armed with steel.

Apparently they had been great wanderers, like many early people. It has been thought that their original seat was in the general neighborhood of the foothills of the Alps on both sides of that mountain barrier, notably in the upper valley of the Danube and in northern Italy. Their route may have been partly through southern France to

Galicia in northwestern Spain, thence by sea to Ireland, then to Wales, Devon and England generally; also partly across northern France to the English Channel, then across into Britain. Curiously there are less positive indications of the latter journey: but, on the other hand, the plainest relics of eastward Gaelic movement in Britain may well belong to a much later time. These are among other things, inscriptions in the Ogam alphabet, peculiar to the Gael, which are fairly plentiful in South Wales, Cornwall and Devonshire, but decrease in number to the eastward, until but one is reported from Hampshire, among the ruins of Calleva. We know of Gaelic inroads and settlements well on in historic times which took this general direction, starting from Ireland.

However they came and wherever they landed, it seems very probable that the Gael gradually won possession of nearly all Britain and Ireland, though Fir-bollig Galway at least long maintained a precarious local independence. Probably the metal weapons had even more to do with this success than their great physique and aggressive temperament. Of course the result does not imply that the earlier people all became Gaelic. It means that they had Gaelic speech and some Gaelic institutions forced upon them, or found an advantage in substituting those for their own. This Gaelic conquest occurred somewhere in the latter part of the bronze age.

The British or Brythonic invasion belonged to the age of steel weapons and may have been facilitated by a better supply of these, as the Gael in their time had defeated their darker predecessors by the superiority of bronze weapons over stone. Rhys thinks that the British Celts probably came at some time between the visit of Pytheas, who seems to have circumnavigated the island about 330 B.C. and landed on it at many points, and the incursion of Julius Cæsar about 55 B.C. Cæsar certainly found them there, but no one is quite sure whom Pytheas found. On the whole it seems most likely that the transfer of population began considerably before his time, but continued later. The last was no doubt true of the final British northward wave, the Belgæ, who were perhaps more or less modified by earlier contact with the Teutons and may have had some Teutonic strain in their blood.

It is likely that the original seat of these Belgæ and perhaps of all the British Celts was in or near Belgium; but they undoubtedly came to Britain for the most part across the Channel from the region where the great armies are now battling. Cæsar found the loosely affiliated tribes of the Belgæ in all northern Gaul or France, but no less in southern Britain from Kent to Hampshire inclusive, and observes that there was little difference between the speech of Britain and that of Gaul. Arras was the Gaulic capital of the tribe of the Atrebates, the elder name having been gradually worn down into the modern one; but they had also a British capital in Hampshire, which later became

the distinguished Roman-British city of Calleva Atrebatum: its ruins have been exhumed on the site of the modern English village of Silchester. Cæsar found the king of the Suessiones ruling over territory in Britain as well as territory in Gaul, and his seat of government bears still the name Soissons, hardly changed at all in spite of many vicissitudes and storms and bombardments. The name Britain itself has sometimes been derived from the Brittanni, who dwelt in the valley of the Somme but removed in numbers to Kent, where they would be more often visited by traders than the inhabitants of distant regions, and their tribal name might possibly come to be used for the island as a whole. Indeed at every turn familiar names crop up from this old time, though most often on the southern side of the channel, where the later hostile inroads were less sweeping and ruthless.

There were however some differences between the populations on opposite sides of the Channel, if we may believe the Latin writers of that period; as indeed there will often be in different parts of the same nation. Thus we are told that the Britons were larger than the people of Gaul, some of them being half a foot taller than most other men; that their hair was less yellow than that of the Gauls and their bodies were not so well set or handsome; that they displayed more vehemence and fierceness in combat; that they were notable for their loud clamor and for going into battle nearly unclad with swords hanging beside their naked bodies; that their wealth was in their cattle; their method of living notably simple and frugal and that they harvested their grain without threshing by cutting off the heads bodily, presumably by the use of a sickle. This method has been revived recently in the case of freshet-flooded grain.

Sometimes these writers may have chiefly had in mind the remoter non-British, or but slightly British, aborigines, as the Britons called them. Other distinctions may be local for single provinces or districts. Of course there would be much confusion between these, but, allowing for a real residuum of average British difference in physique and ways, we may still say that the Britons were transplanted Gauls—in southern Britain Gauls of the Belgic subdivision—and Cæsar says that their speech differed little from that of the neighboring mainland. Rhys has preferred to call them Gauls; but the name is geographically misleading and besides liable to confusion with Gael, which probably had the same root. More frequently the name Brython has been applied to them, but it is unfamiliar to most ears and may seem to savor of affectation. I have preferred the well-known term Briton in this paper, especially as both Romans and Saxons best knew them thereby; although in modern use it often includes all people now dwelling on the island. Perhaps we stand in need of a perfectly satisfactory distinctive term for the

British people who were not yet Romanized nor Saxonized nor Danicized nor Normanized; but we must do as we can.

Neither the Gaelic nor the British language was homogeneous, nor is so now. Each consists of at least three sub-languages, those of the Gaelic being the Erse or Irish, the Scotch Highland Gaelic and the nearly extinct Manx, spoken on the little Isle of Man; the British or Brythonic comprises the Welsh, the Breton and the hardly extinct Cornish, which has left some literature and many habitual words. The latter three differ more from each other than do the former three. Erse, Highland Gaelic, Welsh and Breton, are spoken over considerable regions and each of them breaks up into distinct local dialects. There is no reason to doubt that dissimilarity in details of population and language was the rule both in Gaul and Britain, as we know it to be still in Brittany, though there would be a fair degree of uniformity in the more advanced agricultural and trading regions. Ireland remained Gaelic in culture; so did the upper part of Scotland and some parts of the sea-coast of Wales, where the original or recently invading Gael had established a great reputation for supernatural power, perhaps implying a certain superiority in some quite human arts over the neighboring mountain Britons or Welsh. This would not, however, imply superiority over the more cultured parts of the British people in the same period.

It is difficult to make a comparison between the Gael and the Britons collectively. The former must have been more influenced and modified by the preceding neolithic people of the island; the latter by the Germanic tribes then crowding westward over the continent and mingling with all races before them. As later comers it is fair to suppose that the Britons would be the better supplied with steel weapons and other appliances: and their successful occupancy of the best parts of Britain is a corroboration. But perhaps the Gael had once been directly in contact with Mediterranean civilization and brought thence a greater aptitude and proficiency in matters of art. Of course, in both cases, it is easy to underrate or overrate the old conditions, especially as the relics in the soil of Great Britain may belong to very different periods of the developing British people.

But we have reason to believe that in the more prosperous regions there had been a considerable amount of human attainment. Cæsar refers to the number of houses and density of the population, though he also describes their towns as mere collections of wattled huts defensively walled round in the forest and mainly intended as places of refuge. However, we hear also of wooden houses; and better habitations were coming into vogue. Perhaps in the main they preferred a more isolated farming life. They built strong hill forts. They had many chariots, some of which gave Cæsar his first hostile greeting in the shallow water of the sea-coast; also he presents a vivid account of the dashing and

skilful tactics of the Britons in managing these engines of war so as to throw the Roman ranks into confusion, while the fighting men would spring off and on at will, sometimes running out along the pole of the neck-yoke and back again—the chariot being in motion. They fought, he says, in detachments, with reserves, and obtained by these vehicles in one kind of force most of the advantages of cavalry and infantry; though we know that they had both of these arms as well. In all the southern regions market centers had grown up, using copper and iron coinage, as well as gold coins in their later period, which were perhaps at their best in Essex. The Druidic system, common to them and to Gaul, was understood to have its origin and chief holy places in Britain and constituted a complex religious organization with elaborate training.

During the long period of Celtic ascendancy in Britain foreign influences were brought to bear upon the coastal country at least. Traders from Phœnicia and the Phœnician colonies of the Mediterranean and Atlantic are believed to have crept up to the ocean side; Greek civilization from Massilia and neighboring towns traveled overland across western Gaul and thence to Britain on similar errands. But perhaps neither of these nor any others stirred the islands greatly or penetrated far inland, unless in the faintest way.

The adventurous incursion of Julius Cæsar pierced more deeply. Though it did not maintain its foothold, it opened the gates, introducing Rome to the islanders and the islanders to Rome. Presently the imperial culture prompted imitation, as will happen everywhere in the human shallows a little beyond the flood of advancing civilized life, so that Cunebelline (Shakespeare's Cymbeline), a potentate of Essex, took heart to set up as the friend of Augustus and to prove his sincerity by aping imperial Rome as best he might. Probably some adherents came to him from regions under the Roman sway.

But before such infiltration had reached the inner parts of the island, the new domination which it foreshadowed came with a rush of arms and men, and all resistance was beaten back to the mountain lands. This Roman conquest threatened Ireland from the western shore, but the storming of Anglesea or Mona was its farthest achievement in that direction. It kept on northward to the Highlands and later pushed nearly or quite through them very briefly; but in the end it was content to stand mainly on the defensive behind a strongly occupied line of fortification still known as the Roman Wall; and to bridle western turbulence by great fortresses or legion cities distributed at points of vantage along the line of probable disturbance—Carlisle and Chester to the northward, Exeter in the southwest among the men of Devon, Caerleon near the estuary of the Severn in what we now call South Wales, and other garrisoned towns of note in the intervening spaces. The southern and southeastern seaboards had their strong

fortresses too; and later, if not at first, the exposed eastern front was systematically guarded by the forces of a count of the Saxon shore.

The Roman occupancy of Britain falls naturally into three periods: the first brutality of conquest; the long peaceful domination when there was neither war nor rumor of war except in a small way with mountain tribes on the remote border; and the era of decay when incursions became frequent and disastrous, usurpers abounded, wrangling, and year by year there grew a dread upon all of being cut off alive from the living mass of men. We remember the first period by the extravagance of cruelty which it employed and provoked—the wrongs of Boadicea and her kindred, the massacre of London; but in the fact that there were already seventy thousand immigrants from the Roman empire to be overwhelmed in that blind retribution, we may more profitably study the great change of population that was already working on British soil.

But this was no adequate measure of the incoming flood. Beside the garrisons of the wall and the legionary cities and fortresses, great colonies of veterans were planted in the open country; merchants and mariners gathered at the landing places and in the narrow streets of the growing river towns, and moneyed men from the Mediterranean, the Rhone or the Garonne took up their abode on lands newly bought or granted, building low colonnaded dwellings of open interior and mighty expansion, of elaborate baths and hot-water-heating systems, of tessalate mosaic pavements and profuse frescoing, such as have never been exactly repeated in England since their day. Of course the wealthier colonists would bring or draw dependents from the continent, with cumulative effect on the population.

Moreover, there was a steady double transforming action by the depletion of native young men, persistently shipped away elsewhere to fight Rome's battles, and the continued importation of foreign blood to fight or curb the more intractable people of Britain. There can seldom have been less than twenty thousand legionaries and auxiliaries on the island between the year 50 and the year 400, men drawn from every corner of the empire—Spaniards, Dalmatians, Burgundians, East Indians, Scythians, Syrians, Gauls and Moors. Most of them brought their families or married there; and hardly any people of the world, however unrelated or uncouth, but was summoned to aid in defending or holding Britain—and incidentally to aid in providing her future sons and daughters. At times, of course, the inflow of soldiery exceeded very greatly the figures above given; as when Agricola overcame for a time the independence of North Britain; or when Severus trampled it down again with armies out of which he lost fifty thousand men.

Of course, the effect was not equal nor nearly equal everywhere. In the towns known significantly as "of the legions"; in London which took the legionary name Augusta; in York, long the military and civil

headquarters of the island, it was necessarily great; also greater than elsewhere along the line of the Great Wall, where a continuous more than half-foreign belt of village population may well have grown up. But there were many fertile valleys and uplands which Roman troops rarely visited; many British towns which rarely saw them except as a mere incident of transit; and in all the numerous forests and marshy regions and the rougher country generally the British blood, British ways and British language most likely continued to prevail; although the people outside of the mountain land had very well learned the futility of rebellion.

The Roman rule in Britain lasted for about four hundred years. During the greater part of that time Rome kept order and maintained a fairly homogeneous civilization in all parts of the island best adapted to civilization and commerce. From end to end of the lower country and from side to side it pushed excellent roads, making transit easy; it built great sea-side and river-side embankments; it very greatly multiplied the population; it fostered a relatively great commerce; it developed cities which would be pygmies certainly to those of our century, but were well built and thriving and beautiful; it distributed widely those kinds of advancement which belong more naturally to the shores of the warm southern sea. It must have taught the native people many things—beside a more or less enervating sense of security under protection; but it has been generally credited with undermining their self-reliance, enterprise and efficiency. Perhaps the distinction between the dominant man-at-arms and the docile native citizen was insisted on too overwhelmingly and persistently. Originality in art did not thrive and the country had no literature with vigor enough to leave any trace. Moreover when the Roman legions withdrew there was difficulty in adequately filling their places, and the makeshifts were battered down at last. It is also a significant and rather wonderful fact that the long and elaborate establishment of the Roman system took so little hold upon the hearts of the subject people that a bare handful of Latin words remain from that period in the popular speech, "way," "villa," "camp" and "castrum"—turning at last to Chester and castle—being the instances that come most readily to mind. Perhaps the enfeebled and transformed Britons who had learned to speak a corrupted Latin either followed their masters away from the island or were killed or de-Latinized by later invaders, or took refuge in wild regions, where their language died away in the speech of those about them. Evidently the great previous development of population came to an end long before the final catastrophe and had taken to dwindling again. Possibly if the Roman soldiery had been heavily reinforced and kept at the Great Wall there might have been a northern Roumania, speaking some sort of langauge derived from the Latin and, like the Roumania of the south-

east, claiming descent from Roman soldiers' families. But nothing remotely resembling this came to pass.

The storming of the northern wall must have made a great stir in its time. Gildas, who is said to have been born near one end of it, and who probably wrote about 560, makes it a notable feature of his altogether too brief combination of diatribe and historic treatise. But, in point of fact, it seems to have happened repeatedly, with intervening repairs and remanning, total or partial. The same is true of fortified places behind it. Recent investigation has shown at least three demolitions and restorations of one of these, and we can fix approximately their dates by the coins lost, left and built over, but now again exhumed. The first destruction was not far from 368 A.D., the last later than the year 400. One such little hoard, dating perhaps from about 385, was found where it had been wrapped up in lead with a gold ring and hurriedly stowed away so long ago, evidently before a sudden onslaught. A coin of Honorius on the line of the wall itself indicates that this part of the work at least, was yet in Roman hands about the end of the fourth century. Perhaps the wall ceased before 407 to be an effective barrier as a whole; though its strong terminal fortresses and possibly some intervening fragments may have held out much longer. The Picts and Scots —that is, North British Highland people and the Irish—are reputed the destroyers—the latter perhaps flanking the wall with their ships at its western end, while their allies made the frontal attack which Gildas describes; but the later successful assaults at the eastern end may have come from the Teutonic assailants who soon grew more formidable. Aneurin's very old Welsh poem "The Gododin," attributed uncertainly in part to the sixth century, is interpreted by Dr. Skene to relate in its earliest section the downfall of one of the eastern fortresses of the more northern Roman wall from the Forth to the Clyde.

There is no detailed and nearly contemporary account of the Anglo-Saxon conquest. Several centuries later the West Saxons put together from their traditions a terse chronicle of the events as they understood them. Fragmentary British legends were embodied about the same time or a little later in the brief history which bears the name of Nennius. Later writers gathered other items and romanced about them. We have little else beside the indications of place names; the physical characteristics of living people in different neighborhoods; and the evidence yielded to archeology by the British soil. Of course the picture of events thus gathered is very incomplete and uncertain.

We can clearly see that both Roman departure and Teutonic inflow were very gradual. Maximus in 383 had carried a great part of the British strength southward, to compete successfully in his behalf for the imperial purple. Apparently it never returned. From that time, with

increasing menace, there must have been a gradual depletion of those who could leave.

In 402 Stilicho withdrew altogether from Britain the sixth legion, which had long been stationed at York; also the second legion, to the forts of the eastern coast near London, from Caerleon upon Usk in South Wales, which had been its settled abiding place for two or three centuries. The latter movement marks the increasing Saxon danger, since the Saxon shore became the only region guarded by regular troops in all the island. This is corroborated and emphasized by certain repairs in the fortifications then made at points along that front.

Necessarily all the north and west of England were left unguarded, or to be guarded by native volunteers and levies. No doubt the latter alternative was taken, for there is evidence that irregulars or native troops had been used for some years before to defend the wall, and the native legends and incidental references in old Welsh poetry make it nearly certain that the provincials adopted the Roman methods and organization in necessarily taking the places of the withdrawn Roman troops. The Roman generals would doubtless help them to make some provision before withdrawing. Probably as long as possible the British commanders would maintain the same headquarters. Thus more than a century later we find Arthur still making Caerleon his stronghold and capital according to Welsh tradition. It may well have come to him through a succession of commanders. Also, considerably before Arthur's time, but no doubt after the downfall of York or Eboracum, we seem to recognize Cunedda as the Duke of Britain holding command at the north.

The defense of southeastern England was soon committed altogether to the British, too. After various disorders and revolutions the sole remaining legion elected an "emperor" Constantine 3d, who, following precedent for the last time, carried it to the Continent about 407 in pursuit of his dream of empire. There must have been some provision hastily made to provide a substitute garrison. Naturally the municipal authorities of the various cities would be called upon for that duty in the first instance and their Romanized town levies would be supported by the still imperfectly Romanized or merely Celtic country people and the tribesmen of the wilder regions, these latter, however, being naturally often out of harmony with their urban comrades.

It is generally recognized that there was such a division, with resulting weakness to the defense. The wilder country people held out longest, but only in a kind of qualified barbarism. Civilization is largely an affair of cities and Roman-British civilization was trampled under the Anglo-Saxon heel.

The British cities were unequally equipped to withstand an assault or seige. London had grown up around a fortress, had been walled very

early and was walled again more amply and efficiently when danger threatened. Calleva probably was not walled at all until after the Romans departed. The circumvallation of Deva (Chester), Anderida (Pevensey) and Camulodunum (Colchester) was complete and strong from first to last. Verulam (St. Alban's), with her admirable amphitheater and many temptations to pillage, remained always open.

Their fate was equally diverse. After long beleaguerment, Anderida was so utterly devastated that we are assured by the victors "there was not one Brit left." Verulam, with unknown resistance, if any, disappeared from the living world. London may have lingered on, having withstood the tide until about 585, as a mere paralyzed remnant of its former self, and the effect of its long resistance is shown in a curious prevalence of dark hair and complexion in the wedge of people behind it toward the midlands. Exeter, remote and conquered long after the conversion of the Saxons, was divided between the two races, who dwelt quite neighborly side by side.

For the conquest, though speedily effective over a large area, was, as a whole, the task of several centuries: and as we go westward the substitution of the invaders for the natives became less and less nearly complete. Indeed, it may be doubted whether it was really complete anywhere or at any time except in some very isolated, helpless and deeply hated neighborhoods.

A great rally of the Romano-Britons seems to have occurred in the first half of the sixth century, checking the conquest here, turning it back there and giving time on both sides for cooler thought, a better acquaintance with alien customs, a juster appreciation of enemies. The greatest names of this reaction are Aurelius Ambrosius and Arthur, the former very shadowy to us now, if remembered at all, but the favorite hero of Gildas and apparently of those Romano-British who were most proudly Roman; the latter, the human and efficient champion of the native or distinctively British party, but for many later centuries a monarch of myth and allegory and all emblazonings of poetic fancy. There is no need to go into the details of the various schemes which have been put forward as to his dozen campaigns and victories recorded by Nennius. They seem to have been widely spread, beginning in Lincolnshire near the east coast, including the far north and the far south and ending near Bath in a battle fought probably against Saxons who had passed in their small craft around Cornwall and come up the estuary of the Severn. As already stated, tradition gives him for capital Caerleon upon Usk, the great Roman legionary city for the Severn Valley and the west; but also another capital and stronghold normally nearer the West Saxon frontier, in Camelot, perhaps Queen Camel of Somerset.

It is apparent that the greatest slaughter generally fell upon the city folk and the dwellers in the richer and denser agricultural districts;

and that the most efficient and prolonged defense was made by those who were still hardy and little Romanized, the dwellers about the western foothills, the southwestern moors, the forest-folk, the fen-folk, the people in short who preserved most of the old Celtic and pre-Celtic blood.

It must not be supposed that the immigrants of the Roman-British centuries failed to leave any impress on the final constitution of the population; but it is apparent that the Saxon winnowing ensured in many places something like a reversion to Celtic or pre-Celtic types and ways.

During the welter of that age there was a very considerable reinforcement of Gaelic blood from Ireland, especially in North Wales and in Britain north of the wall, to most of which latter region it gave the name Scotland, strictly meaning the land of the Irish. The Gael of North Wales, both ancient and recent, were overwhelmed very shortly, however, by an eddy of Britons under Cunedda and his successors, who had found the Saxons too strong for them in the region about the Great Wall and fell on the Gael in retreating southwestward. Something like this must have taken place also in the long lower southwestern peninsula of Cornwall and Devon, where the traces of Gaelic occupancy are so plentiful and where the westward crowding of the Saxons on the steadily resisting and slowly retreating Britons was renewed at intervals until the ninth century.

We have, therefore, as a net result of the Saxon invasion and conquest, not only the total destruction of civilization in most parts of Britain and its gradual dwindling in others—but also the production in the eastern, southern and middle districts of a population rather largely, but not wholly, Saxon in the open country; farther west and in rugged places only a little Saxon on the surface, though often Saxon in speech; still farther west unreservedly British; and along the western shore partly Gaelic, though speaking British, now known as Welsh in its modern form. Ireland spoke Gaelic still—and seems to have remained as Celtic as before the Romans crossed the English channel, though there had been more or less trade between Ireland and Roman Britain.

In due time the Saxons, having been Christianized and mollified, began to work out in Britain a new civilization. It was very primitive and rudimentary compared with its Roman predecessor, but possessed elements of strength and hopefulness and aspired to a literature of its own.

Then the draught of barbarism which they had administered to the Roman-Britains in earlier times was held to their lips by those of kindred stock who had remained untaught in truly human things. The Danes and Northmen, during several centuries, ravaged the English coasts in the most pitiless manner (treating the Gael of Scotland and Ireland no better), marched their armies destructively through the

heart of the country, established themselves in great numbers at divers points and even seized the kingdom of England for a time and ruled the land. Sometimes they were beaten back with great losses, as by Alfred; sometimes they were slaughtered by the hatred of their Saxon neighbors, who rose against them. But they were not fundamentally very unlike some of these neighbors; so that the laws and customs of Saxon England may even be studied approximately in the more abundantly preserved Old Norse records, especially the Icelandic sagas. Indeed the Icelandic language, even to one who can not read it, displays a surprising number of words such as wharf, house, land, strand, which are still current among us. All told, the Scandinavian invasion chiefly affected the addition of a few words to provincial English speech and a reinforcement of the blond element in the people of northeastern England, with perhaps a slight increase there in stature and vigor.

Also the sea king inroads had driven the civilization of the island well toward the southwest, where it made a stand under Alfred, and eventually moved forward again.

Ireland, which neither Briton, Roman nor Saxon had reached, now experienced a real cataclysm from the Northmen, who broke up her very promising culture, laying waste the repositories of art and learning and making sad havoc of everything kindly and humane in life. The loss was felt very dreadfully for centuries and some features of it have never been repaired.

When at last the Danes were dislodged, England was no doubt more united and more advanced than at any earlier period since the Romans departed, and a steady gain continued under Anglo-Saxon rule, partly owing to abundant influences and immigration from the neighboring France and Normandy. But the dislodged Danes were persistent in trying to regain their seats, their very last effort—a strenuous and disastrous one—being directed against King Harold only a little before the arrival of William the Conquerer on the southern coast; so that the unhappy island hero had to hurry from his decisive victory at Stamford Bridge to his death in the ring of shields and battle axes on the crest of Senlac.

After that, the great Norman held the land too vigilantly and unflinchingly for any new invasion to be hopeful, so that the Danish episode in the life of Great Britain came to an end. It left the mountain people very nearly as the Saxons had left them, and in race at least practically little changed from even pre-Roman times: and the same was true, as in previous conquests, of many fen-lands, moorlands, forests and the like.

The Norman invasion was that of a tyrannical civilized people rather than of destroying barbarism. It came to Britain as to another Christian country under color of right, though a fraudulent color, and not in

open enmity of race or faith. Indeed, peaceful methods had already carried the conquest forward in some degree before it took on a military guise: consequently the people on both sides of the channel were again more or less alike in stock and culture. Their religious ideals and forms differed little and their political ideals were nearly allied, though perhaps the Saxon had a keener feeling for freedom—for his own freedom at any rate.

The Normans had begun as Norse vikings; but their long settled life among the French and habitual intermarrying had made them largely French in language and many things. On the other side the English had already borrowed many French words and some French ways, but still differed sufficiently to make a plain contrast between the two nations. The Norman despised and hated the Saxon as crudely boorish; the Saxon hated the Norman as aggressive, unrighteous, greedy and cruel, also despised him as vain, pretentious and given to making much of trivial things. Such inhumanity as was shown came from this clash of opinions, or the incidentally excited evil perversity of human nature, not from any settled purpose to destroy. Greed and policy, rather than wanton cruelty, were evidenced by the extensive confiscations of land or shifting of title and the many inflictions designed to keep down the vanquished. As we all know, the bitterness engendered by differences of custom, language and temperament, and much more by the oppression of the conquerers, died slowly away.

This Norman conquest, like most of its predecessors, proceeded from the southeast to the remoter quarters of Great Britain, but was very much more rapid than any other of like permanency. After the collapse of the main Saxon power below London, William still had to fight in the north before the gates of York and in the far west about the walls of Exeter; also, longer and harder than almost anywhere else, amid the marshes of Cambridgeshire, where Hereward, the persistent partizan leader, had established on the Isle of Ely his city of refuge. But there was no immediate conquest of the Welsh mountains or Ireland, though both were penetrated later, with great suffering to the natives and every kind of wastefulness. The highlands of Scotland remained Gaelic in tongue; Wales and Cornwall with some bordering territory retained their British speech and the changes of their population were very slight at first and probably only moderate afterward.

In the main body of England there were developments of language rather than linguistic revolution, a great extension of the English vocabulary by French and Latin words, chiefly introduced to answer new needs, and certain innovations in forms of speech, some of which (such as double negatives) have been only temporary in good usage; but the general character and type of the language remains unchanged.

As to racial modifications we can be even less certain than in some

earlier instances of invasion, for the conquerers themselves were very complex. They contained Germanic and Celtic elements and drew recruits from the unlatinized or delatinized Bretons no less than from the at least superficially Latinized French and peoples farther afield. It is becoming also increasingly probable that, under all these, a substratum of still older submerged races supplied and still supplies the greater and more enduring mass of the French people. Allowing for the considerable amount of Scandinavian blood among King William's Normans, it seems altogether likely that this conquest did not greatly vary the racial composition of the island people, setting minor distinctions aside. That on the whole it tended rather toward darkening the English race than lightening it in complexion may be plausibly argued from the great number of adherents which Brittany, next neighbor of Normandy, had supplied the Conquerer both before and after the invasion; also perhaps from the special favor which was soon extended to the British-speaking natives of the island, so long as they refrained from revolt. There was at least a precarious basis of good will in a common enmity for the Saxon. The Norman court and aristocracy readily seized on the historic legend of King Arthur, the Champion of Britain against Saxon invasion, and wove the most remarkable tissue of romance about it which the world has ever seen. This made unquestionably for Celtic prosperity, multiplication and immigration. But the Celt at that time as now, wherever found, was less often blond than dark, less Celtic in aspect than pre-Celtic. So that type was at least not appreciably diminished by the Norman invasion.

In later years there have been no more waves of conquest rolling over the lowlands of Britain though there have been wars and reformations and revolutions, changing many things. As a net result, ethnologically speaking, the Gael have been pushed farther back into the northern mountains and have lost some ground in Ireland in favor of more or less Saxon and Norman invaders. On the other hand, they have peacefully invaded the English and Scotch cities and many country districts, more than compensating for any partial extirpation of their stock in seats formerly held along the western coast of Britain. There have been other immigrations and shiftings of population from time to time, but nothing that should appreciably change the racial map of that island, though the linguistic map as stated would show a progressive shrinking of the Welsh and Gaelic areas; at least until quite recent years, when special influences of expansion began to work in both cases, with doubtful final outcome.

My general conclusions are, therefore, that the racial composition of the people of Great Britain has been but moderately affected by conquests and other events occurring since the sixth century; that from a period antedating all history one of its most permanently important

racial elements has been a dark-haired neolithic race, of which we know very litle indeed; that in the far north and in most parts of Ireland the Gaelic Celtic race is next important and measurably supplies language; that in the west of Britain the Welsh, or British Celtic, race takes its place, though accompanied by notable Gaelic and Saxon and some Norman elements; that the originally Teutonic races, Anglo-Saxons, Danes, Northmen and Normans, now pretty well blended everywhere and only locally and doubtfully distinguishable, are conspicuous in the lowlands of Scotland, the northeast of Ireland and most of the eastern and southern lowlands of England, being in the majority in a few districts and supplying the exclusive language of both islands, except in the restricted Welsh and Gaelic areas. In Great Britain at least they have attained and held a general political supremacy, though with important exceptions, and have contributed perhaps rather more than their full share to the various activities of the island. But as their language is blended of materials from many sources woven on a low German framework, so their race is blended of constituents from many immigrations and conquests filled into a framework that is neither Saxon nor Celtic, but perhaps mainly pre-Celtic, whatever that may be.

BATTLES AND RAINFALL

By ALEXANDER McADIE
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"Do battles cause heavy rains?" This question is being frequently asked by many who ordinarily are not disposed to readily accept the view that such a relation exists. Their skepticism has been somewhat shaken by the fact that battles probably the noisiest and bloodiest in history are in progress and coincidently heavy rainfalls have occurred near the battle territory and elsewhere.

The explanation which first suggests itself is that concussion due to cannonading has shaken down the raindrops. But there is no physical process known that directly connects rainfall and concussion as effect and cause and physicists unanimously agree that such a relation seems improbable. The first definite objection is that the air and water-vapor are not themselves transported by an explosion or any violent agitation like that due to gunfire. There is no transference of the medium itself any more than in the case of a sound wave. Waves of compression and rarefaction are in the nature of a progressive pushing and pulling, each molecule pushing its neighbor a short distance forward and then pulling it back. To make it still more plain, the air disturbance would be like those compressional waves in the earth's crust which every earthquake starts and which are recorded on seismographs.

The most violent explosion in air, therefore, would not remove any appreciable volume of air and vapor from one locality to another, while it would cause a pressure wave, and as in the case of great volcanic eruptions like Krakatoa, Mount Pelée and Katmai, a wave of sufficient intensity to be noted at observatories around the world. Such a wave encircles the globe in a few hours, and so far as we know has no effect in causing rain. But, on the other hand, it is true that in all great volcanic eruptions large quantities of dust particles (dust is the general name for all nuclei in the air) are injected into the higher air currents and carried from place to place. These do play a part in facilitating condensation and consequent precipitation. Krakatoa dust encircled the world in fifteen days and eventually probably caused excess rain in some localities. In this indirect way, rather than through concussion, it is conceivable that rain and explosions may be connected. But a volcanic eruption far exceeds in violence gunfire, even that of the greatest battles in modern warfare, and there is a vast difference between the gases generated and other output. The eruptions at Katmai,

Taal, Asama Yama, Bandai San, Tarawera, Mount Pelée, the Soufrière of St. Vincent, Krakatoa, and even little Lassen, emitted enormous volumes of gas, fine ash and coarser matter. At Katmai, for example, the output was so great that the deposit at Kadiak 121 kilometers distant (75 miles) amounted to 35 centimeters (14 inches) of fine granules of sand, orange and yellow dust and pumice. Again, the intensities of the air shock, if we may so express it, are very different in eruptions and battles. Tornadic inrushes occur near the volcano and for some distance; while the wind rush of the largest gun when fired is hardly different from that of a passing train. A crude comparison of these relative intensities may be gleaned from a note made by Omori, the foremost seismologist of Japan, to the effect that during the Asama Yama eruption (December 7, 1909), there were marked pressure changes on nearly all the barographs in Japan and to a distance of 160 kilometers (100 miles), while in the city of Tokio, the daily noon gun fired close to the Central Meteorological Office never affects the instruments there. At Blue Hill Observatory, we have never been able to detect changes due to the firing of the big coast guns, or those of the fleet when manœuvring.

It, therefore, seems but fair to conclude that to cause rain, gunfire would have to be on a vastly greater scale than is at present the case. And, as for the attempts which have been made to produce rain by bombarding the clouds, it is enough to say that the claims and statements made by the experimenters, or shall we call them exploiters, are not supported by the facts.

Some years ago at Santa Barbara, during a prolonged dry spell, a meeting of the citizens was called to consider an offer from a temporary resident, a Michigan millionaire, to furnish all explosives needed to produce rain. This gentleman claimed to have successfully caused rain by these means on his ranch in Texas, during cloudy, threatening weather. While the meeting was in progress, rain began to fall and there was no further interest in explosives. This incident is referred to here because if the meeting had been held a day or two earlier, and the proposal accepted and the firing begun, it would have been extremely difficult to convince the people of that section that the rain was not directly connected with the firing. Men's ideas of the nature of the atmosphere are still very vague, and with this indefiniteness goes a corresponding readiness to draw conclusions from insufficient data. Sir William Ramsay has pointed out somewhere that the discovery of the true nature of air was held back for years because of erroneous ideas regarding combustion.

We may then dismiss the attempts of the American rain-makers and also the hail-shooters in Europe as inconclusive. There is no reliable evidence that such efforts have caused rain or any increase in the rain-

fall. Nor is it established that rain follows heavy battles and excessive firing. Records properly assembled disprove the existence of any positive relation between concussion and rainfall.

Still, it would be unwise to assert that our knowledge of the formation of rain and particularly the structure of a raindrop is such as to enable one to say that rain production is beyond the power of man. Furthermore, much that appeared to be fundamental and basic in physics, a few years ago, has now gone by the board or been so modified that the physicist is, to speak frankly, at sea regarding the structure of the atom and the nature of action at a distance. We know very little about the behavior of the large ions in air, also the small and intermediate ones, and their respective mobilities. In fact, we can only surmise as to the rôles played by these molecular clusters in actively assisting condensation and precipitation. We know that if the nuclei are filtered from air, condensation even with saturation is very slow. We also know that some of the nuclei are electrified but the great majority are not. There appears to be an intermediate state between gas and liquid. Through the investigations of Aitken, Wilson, Thomson, Barus, Langevin, Pollock and others, we picture the large ion as a nucleus on which water molecules are adsorbed (not absorbed), the extent depending upon the vapor pressure, and the whole being electrified by the small ion. We have been taught to believe that cloud formation is a physical process in which the effective factor is cooling. The cooling may be brought about by elevation, radiation, contact or conduction and mixture or convection, yet we may not shut our eyes to the possibility of electrical action in controlling the combination or agglomeration of minute particles. Just how this would take place or just how the raindrop and snowflake are built up is not yet known, nor how the process can be accelerated or retarded. Indeed if this were known, man would be nigh unto control of the rain, or at least have in his hands rudimentary means for compelling or preventing precipitation. Job's query which has remained so long unanswerable

Who shall number the clouds, who shall stay the bottles of Heaven?

would be less of a poser. Stranger things have happened than that man should find a way to master the water vapor in the free air; and, for example, to dissipate the clouds and fogs. To make a commercial success of the process, however, would be another story.

Finally, it may well be asked if battles do not cause these abnormal rainfals, what does cause them; and why are some seasons so entirely unlike others? The best answer available at present, though by no means an assured explanation, is that the circulation of the lower air varies in different seasons; and this circulation is controlled by certain "low" and "high" pressure areas. The probability of this relation

was first pointed out by a Frenchman of Scotch descent, M. Leon Teisserenc de Bort, the investigator who with his colleague, the late Professor Lawrence Rotch, did so much to add to our knowledge of the upper air; and in fact discovered the stratosphere. He was seeking for the explanation of certain cold spring months in the very region in which the war is now raging. Other meteorologists have carried the work further and we now think we know the cause of late springs and early springs on the Atlantic coast. There appears to be firm ground for asserting that when a marked hyperbar or excess of pressure overlies the northwest Atlantic, persisting for a week, a fortnight or even a month, the surface flow of air or winds will be mostly northeast and of moderate intensity. Such winds carry large volumes of water vapor and unless the land temperatures are high, the result is foggy, cloudy weather along the shore from Maine to New Jersey. This makes for a relatively late spring and cool summer, on the one hand, and a relatively warm winter, on the other. Similarly on the Pacific coast, it has been shown by the writer in his "Rainfall of California" that dry periods in the winter, which is normally a wet season, and wet periods in the early summer, which is normally a dry time, are directly associated with the location of certain hyperbars and infrabars. Just what are the determining causes in building up these centers of action the meteorologist can not yet say; and hence no accurate seasonal forecasts are possible. Weekly forecasts are indeed attempted by the Weather Bureaus of this and other countries; but, it may be frankly admitted, with only partial success. Still a beginning has been made and there is no doubt in the mind of the writer but that discoveries will be made and improvement follow.

SOME PHENOMENA OF FLUID MOTION AND THE CURVED FLIGHT OF A BASE BALL

By Professor W. S. FRANKLIN

IT is widely believed that a descriptive science like botany is fundamentally and essentially different from a mathematical science like physics. The one certainly does contain all that is vital in art in its sympathy with observed life and its interest in natural form as of leaf and flower; whereas the other is usually thought of as the negation of art in its interest in dead material and its dependence upon the highly conventional and abstract forms of algebra. This point of view was generally held even among scientific men half a century ago, but it is now relegated to that overflowing museum of caricatures, which it seems to be the chief function of the old-fashioned classifying philosophy to fill.

All science is descriptive. The object of this paper is to illustrate a descriptive phase of physical science, and the paper is put into the form of picture-and-legend to emphasize its descriptive character. The paper is incomplete, however, in one respect, namely, in respect to How much? How far? How long? Indeed it is in connection with this quantitative aspect of physical science that algebra is mostly used, and it is here that the essentially descriptive character of the science is nearly lost sight of. There is, however, something essentially descriptive in the use of algebra honestly according to what may be called the Maxwellian method, where algebraic forms spring full-fledged and rich from highly elaborated physical ideas, and there is little besides humbug in the method so elegantly employed by Ampère and so often employed by others where the natural path to a discovery is obliterated and replaced by elaborate algebraic synthesis *after the discovery has been made.*

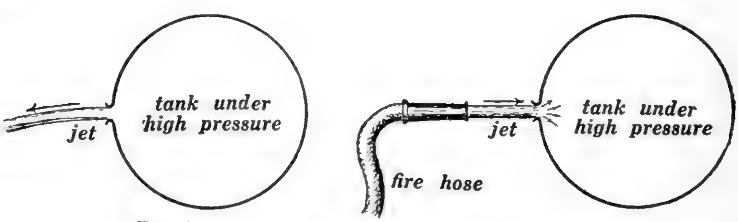

FIG. 1. FIG. 2.

In the tank the water has a high pressure and low velocity, and in the jet the water has low pressure and high velocity. Fig. 2 represents a fancy method for pumping water into a steam boiler; namely, by squirting a jet of water at a hole in the side of the boiler.

The steady curvature of path of a rapidly spinning baseball is explained on the basis of a principle which was first enunciated by Daniel Bernoulli in 1726. Bernoulli's principle is illustrated in Figs. 1 and 2. *In a stream of water or air the pressure is high where the velocity is low, and the pressure is low where the velocity is high.* There are certain limitations to this principle which need not be discussed here.

Air flows through a tube *CD*. Where the section of the tube is small, at *a*, the velocity of the air is large; and where the section of the tube is large, at *b*, the velocity of the air is small, as indicated by the two letters *V* and *v*. Furthermore where the velocity is large the pressure is small and where the velocity is small the pressure is large, as indicated by the two letters *p* and *P*. The low pressure of the air at *a* draws the liquid up in the tube *T*, and the large pressure of the air at *b* pushes the liquid down in Tube *T′*.

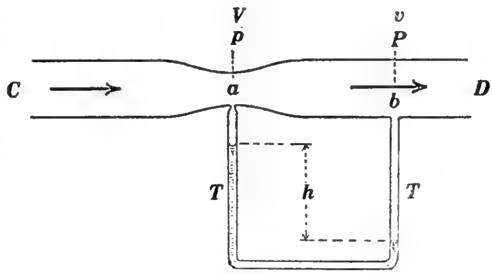

FIG. 3.

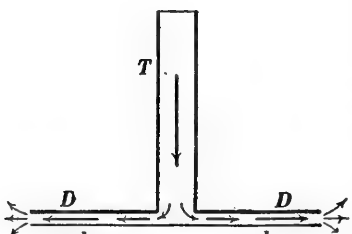

FIG. 4.

A brass tube *T* is soldered to a brass disk *DD*, and air is blown through the tube *T* and against the loose disk *dd*. The air between the two disks has a large velocity, but this velocity decreases greatly towards the edges of the disks because of the great increase of the sectional area of the air stream, and it decreases still more as the air (by virtue of its momentum) pushes itself out between the edges of the disks into the surrounding air. Now the pressure of the surrounding air (where the velocity is low) is high, and the pressure of the air between the disks (where the velocity is high) is low. Therefore the surrounding air exerts greater force in pushing the disks together than the force exerted by the air stream in pushing the disks apart. That is, the disk *dd* sticks tighter and tighter to *DD* the harder one blows through *T*.

This represents a hydraulic analogue of Fig. 4. The rapidly moving water on the disk is at a low level, and it lifts itself to the higher level of the still water in the basin as it flows off the edge of the disk *dd*. Therefore the still water underneath the disk has a higher pressure than the moving water on top of the disk so that the disk is held up. The pin *p* serves to prevent the disk from moving sidewise.

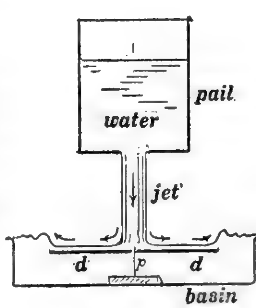

FIG. 5.

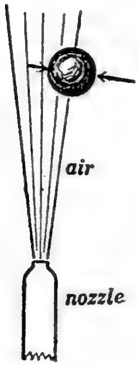

FIG. 6.

This shows a light ball floating in an air jet. The air in the jet pushes up on the ball and keeps it from falling, and when the ball starts to fall out of the jet the surrounding air pushes it back into the jet because the pressure of the surrounding air is high (where the velocity of the air is low) and the pressure of the air in the jet is low (where the velocity is high).

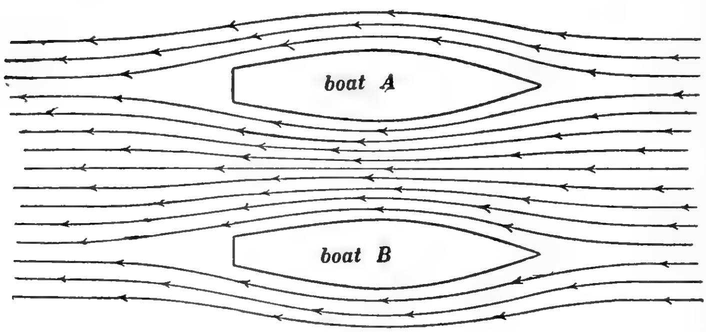

FIG. 7.

This represents two boats moving along side by side in still water, or what amounts to the same thing, two boats standing side by side with water flowing past them. The stream is greatly compressed in the region between the boats, and the velocity in that region is high, higher indeed than it is on the outside of either boat. Therefore the water level (which corresponds to pressure) is lower between the boats than it is on the outside of either boat, and the higher water on the outside of the boats pushes the boats together. It is a well known fact among navy men that two boats which are steaming along side by side are powerfully drawn towards each other.

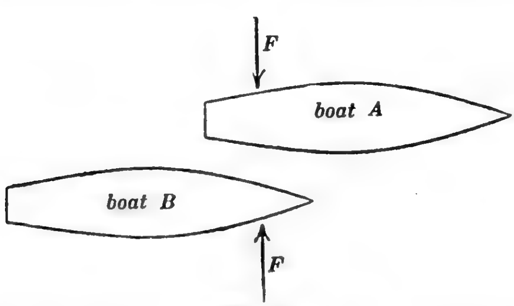

FIG. 8.

The most serious condition which can arise when one boat is steaming past another is shown in this figure. The two forces *FF* with which the boats are pushed towards each other tend to turn the boats, thus the boat *B* is powerfully turned towards boat *A*, and a collision is almost sure to take place before the rudder can be properly set to keep the boat from turning.

The effect which is described in connection with Figs. 7 and 8 may be shown by blowing between two light rubber balls which are suspended as here shown. When one blows between the balls the balls come together with a bump.

FIG. 9.

The following four figures lead up to an understanding of the curved flight of a spinning baseball, and Figs. 10, 11 and 12 must be thought of together.

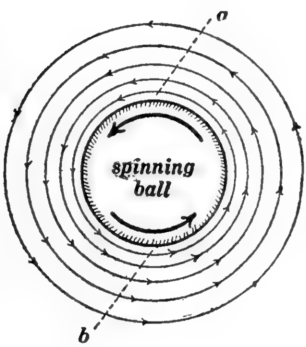

FIG. 10.

This figure shows the whirling motion of the air in the neighborhood of a spinning ball.

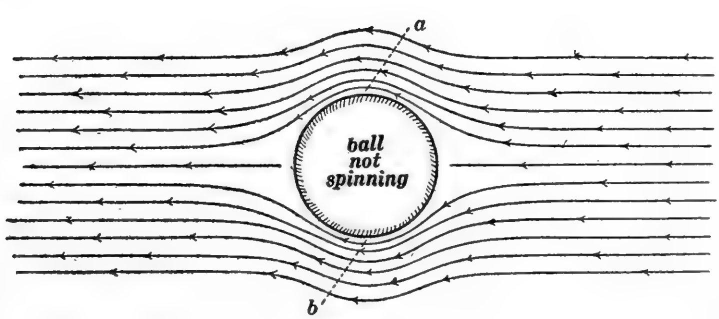

FIG. 11.

This figure shows the motion of an air stream flowing past a ball which is not spinning. The stream splits and flows equally around the two sides of the ball.

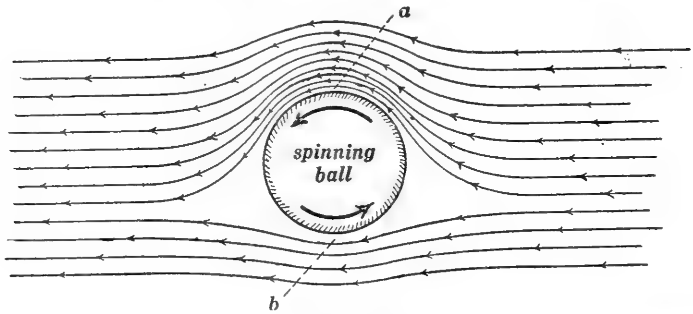

FIG. 12.

This figure shows the motion of an air stream as it flows past a spinning ball. The velocity of the air at the point a is partly due to the spinning motion of the ball as shown in Fig. 10, and partly due to the stream as shown in Fig. 11. That is, the two causes which are shown in Figs. 10 and 11 act together to produce a large velocity at a, and the two causes which are shown in Figs. 10 and 11 oppose each other and produce a small velocity at b. Therefore the velocity is large at a and small at b, and consequently the pressure is large at b and small at a. The air at a therefore pushes down on the ball with a small force f, and the air at b pushes up on the ball with a large force F as shown in Fig. 13.

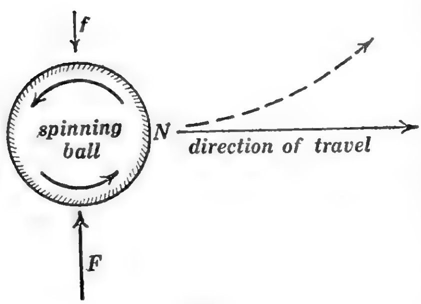

FIG. 13.

The action in Fig. 12, where a stream of air flows past a spinning ball, is exactly the same as the action which takes place when a spinning ball travels forwards through still air, as shown in this figure. A large force F pushes up on the spinning ball, and a small force f pushes down on the spinning ball. Therefore the ball curves upwards as shown by the dotted arrow. Of course the upward force F must be much greater than the downward force f to produce an upward curvature, because the downward pull of gravity on the ball must be overcome.

The point N on the ball may be called the *nose of the ball*. This nose is traveling sidewise because of the spin of the ball; and the ball curves towards the side towards which the nose of the ball is traveling.

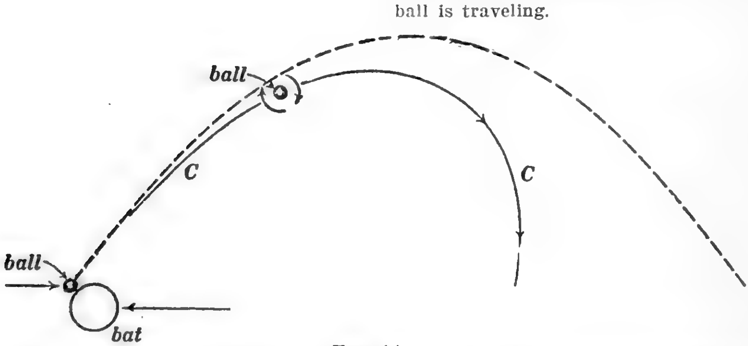

FIG. 14.

The curve CC shows the path of a high foul. The ball strikes the bat and is set spinning in the direction shown by the small curved arrows. If the ball were not spinning it would follow the dotted line, but the spinning of the ball causes it to be deflected continually to one side, as explained in connection with Fig. 13, so that the ball actually follows the path CC.

A ping pong ball is thrown upwards by shooting it with the thumb, marble-fashion, so that the ball is set spinning in the direction of the curved arrows. The dotted line shows the path which would be followed by the ball if it were not spinning, and the full line shows the actual path of the ball.

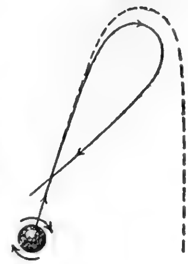

FIG. 15.

THE SPIT BALL

Imagine a perfectly smooth ball traveling through still air. There is certainly no reason why the ball should be pushed to one side rather than the other; therefore one may conclude that the ball will not be pushed to either side! In the same way there is no reason why a sharp-pointed stick standing exactly vertical on a hard floor in a quiet room should fall one way rather than another; therefore we may conclude that the stick will not fall either way! This is good logic in both cases, but it is bad physics. The ball *is* pushed to one side or the other, and the stick always *does* fall. The vertical stick is in what is called an unstable state, and an infinitesimal disturbance is enough to start the fall in some direction, and then away she goes! Also the motion of a smooth ball through still air involves a condition of instability, and an infinitesimal disturbance is enough to start an action which rapidly develops and pushes the ball decidedly to one side or the other.

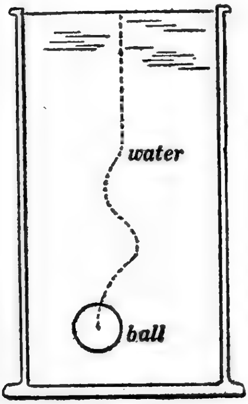

FIG. 16.

This shows the irregular zig-zag path of a smooth ball (not spinning) as it sinks in water. The ball travels nearly straight until it attains a certain velocity, and then it follows a zig-zag path until it reaches the bottom of the vessel. A smooth ball (not spinning) also describes an irregular zig-zag path as it travels through the air, but the irregularities are much less than in the case of a ball moving through water because the density of the air is so small as compared with the density of water. The cause of this irregular zig-zag motion is analyzed in the following figures.

Fig. 17.

Every one is familiar with the peculiar curling motion of a rising streak of cigar smoke in still air. The first part of the stream is smooth, but as the velocity of the rising smoke increases, the stream becomes unstable and develops into a complicated set of eddies and whirls. The boundary between a rapidly moving stream of air or liquid and a stationary body of air or liquid is unstable, especially if the velocity of the stream is great; and this instability always shows itself by the development of a complicated set of eddies and whirls.

When a gas jet is not turned up too high, the velocity of the gas in the jet is low and the stream of gas is smooth as shown by the sketch *a*. If the jet is turned up too high, however, it becomes very turbulent (full of eddies and whirls) as shown by sketch *b*, and in this case the flame produces a roaring sound. The loud hissing sound of a steam jet is due to the extremely fine-grained eddies and whirls which are formed along the boundary between the rapidly moving steam and the adjoining still air.

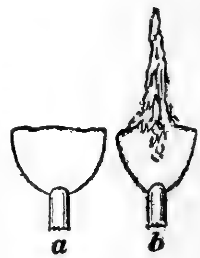

Fig. 18.

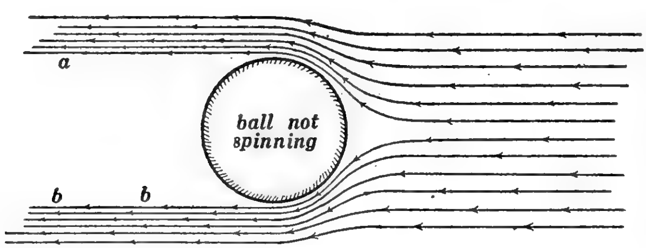

Fig. 19.

This figure shows a stream of air moving past a ball which is not spinning, the velocity of the stream being rapid so that the stream breaks away from the ball as shown, giving two boundaries *aa* and *bb* between rapidly moving air and stationary air. Such boundaries are unstable as exemplified by the behavior of the smoke jet in Fig. 17 and the gas jet in Fig. 18. Therefore eddies and whirls develop along *aa* and *bb*, and as a result the stream at *aa* will be at one instant deflected downwards (in the figure) and at another instant upwards. The same thing may be said of the boundary *bb*. Whenever the stream at *aa* (or *bb*) is deflected downwards (in the figure) a force of reaction is brought to bear upon the ball pushing it upwards (in the figure), and whenever the stream at *aa* (or *bb*) is deflected upwards a reacting force is exerted on the ball, pushing it downwards. Therefore the ball is pushed irregularly to one side and the other repeatedly. The action here described refers to a stationary ball with air flowing past it, and exactly the same effects are produced when a ball moves swiftly through stationary air or water, and the irregular side forces which are exerted on the ball cause it to describe a zig-zag path.

HUNGER AND FOOD

BY PROFESSOR GEORGE J. PEIRCE
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THE most important chemical change taking place in all nature, at least as far as living beings are concerned, is the combination of carbon-dioxide gas and water into food. Going on under our very eyes, in every green leaf in the sunlight, this chemical process converts a useless constituent of the atmosphere into sugar by combining its component atoms with those of water. From the sugar are built up all the other foods of all plants and all animals. The details of this chemical change are only partly known, the intermediate stages have so far escaped the most acute research; but we know the raw materials and the products; the energy used in effecting the change; the means of absorbing this energy; and the place where it is applied. The energy is light rays of certain wave-length; the absorbing screen is leaf-green, chlorophyll; the place of application is the green cells of plants. The raw materials are the most universally distributed substances in nature—carbon-dioxide, occurring in the atmosphere to approximately .02 per cent., and water, occurring in the amounts which we, living in this semi-arid region, realize much more accurately than our fellows in those parts of the "temperate" zone where life is maintained only with difficulty, through summer as well as winter, because of climatic violence.

The daily transformation of enormous multiples of six molecules of CO_2 and six molecules of water into single molecules of sugar, accomplished in weed and grain and tree, results, in the course of a single growing season, in harvests of astonishing values. The values of the crops of the United States in recent years, so far as available reports show, are as follows: cereals ('11) $4,280,205,000; cotton ('11) $8,125,140,000; forest products $195,306,283; fruits $76,709,195; hay ('11) $784,926,000; honey $5,992,083; orchard products $140,867,347; peaches and nectarines $28,781,078; peanuts $18,271,929; plums and prunes $10,299,495; potatoes $233,778,000; tobacco $85,210,387; vegetables $209,548,021; wool $75,879,251—a total of $14,269,854,069 for the farm products of the United States alone in a single year.

To this huge sum must be added the value of all the various forms of live-stock raised during the same year, $5,296,421,619; for the subsistence of these flocks and herds and bands is the product of the same chemical changes, the combination of CO_2 and H_2O into food. Every article of human consumption and use which is not mineral owes its existence to the same source of food. Is it any wonder, therefore, that

I have called this the most important chemical change in all nature? But is it any great wonder that a botanist, entirely ignorant of economic theory, should be led, by his reflections on this important phenomenon, to enquire into some of the relations of man to food production. I make no claim of novelty in point of view, of freshness of material, of the discovery of new facts, but nevertheless I should like to share my reflections on hunger and the means of meeting it?

Looking over this list of commodities of plant and animal origin, we find some which must be called absolutely indispensable, whilst many others, commonly spoken of as necessaries of life, would not be proved by experience to be more than comforts. Clothing, shelter and all the numerous articles of pleasure, from violins to tooth brushes, man could do without, but food and drink he must have. Of what man eats much is unnecessary, either in kind or amount. To the bare subsistence of humanity a minimum ration of protein and carbohydrate is absolutely indispensable. What this minimum ration is does not matter: but what does matter is that so few individuals, so few communities, so few nations even, produce it. This is the peril that many have seen—a succession of seers not without honor, and ridicule, through the ages—it is a peril which varies in gravity according as the balance varies between production and consumption.

The war has exposed to all the world that certain of its great nations are not self-supporting. To those of us who live in parasitic comfort, the idea of self-support is of theoretical interest only, a moral ideal which may have been taught us but the enforcement of which was left to circumstances. Until division of labor began to be generally practised, self-support was not merely an ideal, it was a necessity. Self-support is still necessary among pioneers; but in established communities division of labor has made a decreasing fraction of the population self-sustaining. Division of labor and specialization, resulting in the more rapid and more perfect performance of certain actions or functions, benefit the community and the state by the increased quantity and improved quality of the product. But this benefit has its disadvantages also, for the benefit is accompanied by risk. On the frontiers of civilization the individual must be self-supporting or die. A later development is the self-supporting community. Such the New England farming community used to be. With the completion of the New England adage, "God made the country, and man made the town, and the Devil made the small country town" came also the beginning, in this country, of those larger communities which were less and less able to support themselves as they grew larger, more influential and more prosperous. What sort of prosperity is it, however, that can not feed itself, clothe and shelter itself, that has to be served with every necessity as well as every luxury? And what a topsy-turvy world we live in, when the acme of prosperity

is the maximum of dependence, and complete parasitism is the admired ideal of civilization! The development of civilization, with its continued adherence to the moral ideal of self-support, has seen larger and larger social units excused from attaining it. Have we gone far enough, or for the time being at least perhaps too far, in this direction? This question will be answered variously according to age, occupation and imagination. But each can realize that his answer will be a resultant, a compromise, of contradictions. Individualist and socialist, competitor and cooperator, idealist and reactionary, are side by side within each one of us. Each of us adjusts his life as he may, circumstances and will determining what we do and are, with conscience calmed by the ethics of our particular occupation.

It sometimes happens, in the life of a college officer, that he is invited to speak to another audience than the one which seeks him regularly for leading in the special path which is his life-interest. Sometimes he is talked to as an elder brother by those with whom he has become friends. Such opportunities are rare. They are correspondingly precious. They must be met by clear sight and honest thinking, to be realized at all. In such instances, what do we say or do?

With an increasing population, guaranteed in times of peace a longer span of life through the development of medicine, surgery and preventive medicine, with increasing urban populations, increasing disproportion between parasitic and self-supporting human beings, decreasing areas still untilled, and decreasing production on too large a proportion of the cultivated areas, is it not wise to question whether the world's condition is altogether safe? The economist may say that the law of supply and demand will control. Doubtless it will and does, in the long run; but if the supply lag behind the demand, who will suffer? There is no question of the demand for food; but because its production is possible so far only in the course of a season's growth, by means of that chemical process which combines CO_2 and H_2O, not by manufacture, the supply may lag months behind the demand. If the season be bad or the laborers, the producers, too few, the supply will lag still longer. What can trade, or the practise of the professions, do to supply food, actual food, to even the minimum ration of protein and carbohydrate required by every human being to sustain life? The most intelligent, if not always the most energetic, young people of the civilized world seek to attend the colleges. There they are led along the ways of parasitism and away from self-support, trained for trade, for the professions, and, in the case of young women, for attaining an *ad interim* livelihood by teaching the children of others in the elements of knowledge.

I am not implying the desirability of converting our colleges into "cow-colleges," but I am advocating the serious reflection of old and young upon the question of continuing and increasing the world's supply

of food. Some of our students, perhaps most obviously in the biological courses, are wondering how they can put their training to best use. When I told a young man, some years ago, who was paying his way through Stanford by producing and selling milk, that he would be a more useful citizen if he gave up his idea of becoming a teacher and devoted himself to the calling for which he showed evident aptitude, I was pleased that he followed my suggestion and went into the dairy business. But he didn't *fit* himself for it; he developed an inflated business, and presently went on the road to sell stoves! The fate of his milk business you can guess.

Some of my friends have sons interested in agriculture. One of them says he has told his son that it is not open to him, for he has no capital to start on. Is the practise of agriculture open only to the capitalistic class? Our immigrants do not think so, nor do the real-estate operators so assert; and the increasing comfort year by year of the farmers of the country, starting on leased or on government land, working at first or always with their bodies as well as their brains, attest both the ability of the man without capital to win for himself a livelihood and the satisfaction of serving his country well.

Because of the remarkable qualities of their sunshine, temperatures, and soil, California and the Pacific coast have seen the development of specialized farming on an unprecedented scale. The result is full of danger. The war has closed the European apple market, and we all were able to buy apples for about half the cost of last year. The citrus market is one peculiarly sensitive to unfavorable financial conditions. Fruit is abundant here, but only the fanatical would think of living exclusively on fruits and nuts. The price of bread has risen in many other places than Berlin, despite the bumper crops of California, Utah, and other grain-growing states. Potatoes are an uncertain commodity to buy. There has been no corner, no artificial rise in potato prices here this year; but good potatoes are not as abundant as good oranges, though on the whole more nourishing and more necessary. The price of meat is said to be no higher than a year ago, but a part at least of the European market has gone for the time, perhaps for a long time, because the money to buy meat has been spent on ammunition.

I can not feel that scanning the market columns in the trade and daily papers serves any other purpose than to inform us of what is. The country, intelligent people, must look as far ahead as they can. What the world needs and will always need is food, producers of food, and distributors of food. The man who, though not a farmer, can help the farmer in any way, will always be useful. And that man, that community, that state, which is best able to feed itself, will be the safest. Of the nations now at war, one is safe, Russia. Hungary is safer than Austria, France is safer by far than England, Germany's plight may be

made light of by its partisans to-day, but the prosperity of empires founded mainly on manufacture and trade is at best insecure. To my mind, one of the greatest lessons of the times is the wisdom of self-support. It is more than a moral ideal: it is common sense, the expression of stern necessity.

The development of manufacture is commonly desired by the community and the state. Manufacture implies raw material. Raw material comes either from the accumulation of ages in mine and forest, or from the yearly product of plant chemistry. In so far as manufacture consists in the rapid treatment of the accumulations of ages, it may arouse the opposition of the conservationists, who meanwhile are enjoying the results. But in so far as it consists in the treatment of the year's harvest, it must be supported by more than the granting of mill-sites, tax exemption, and boom "literature." It too needs the producer, for it is not self-supporting. It is a trite saying that agriculture is the basis of prosperity. Without agriculture, the artificial stimulation of natural production, the top-heavy animal kingdom would be doomed. Consider what has been accomplished since the pilgrims first landed at Plymouth, the first settlers at Jamestown, the Padres in San Diego! The established balance of nature on the continent of North America has been completely destroyed. In place of the large population of forest and prairie plants, of game and other wild animals in large numbers, and a comparatively small number of human beings, there have come millions of people, the extinction of certain animals, the destruction of forests and of the plant cover which held the soil and kept the streams clear. There has been great increase in the production of food, both plant and animal, but that the proportional increase in the production of food has been maintained, or is being maintained, is doubtful. Who is to continue production so that it shall be proportional to consumption? The law of supply and demand? If so, then some must be hungry before it will be so plainly profitable that even the dull will see that we must produce more per acre, more wheat, corn, alfalfa, oats, barley, rye, more meat. The securest livelihood may be obtained by meeting the largest and most constant demand. That demand is for food. The supply is for us to furnish, to advocate, to aid, and to consume.

The thesis which I have thus advocated is so reasonable—and so obvious—that there must be weighty objections else the American would not have been converted from sturdy farmer into nervous business man in so short a space of time. A friend once defined "good times" as those in which "a large stream of money flows through one's pocket." Here is at once a difference between farm and city. The farmer is not paid off Saturday night. There is no stream of money flowing through his pocket. He may have a large sum in his pocket at one time, but he is

quite as likely to have as little as a professor at another. But it is not necessary for me to discuss the matter of payments to and by the farmer; nor those matters, inside and outside the farmhouse which have occupied the Country Life Commission, with results which have so far escaped my knowledge. On the other hand, there are certain changes in the hazards of crop production which fall more properly within the field of the biologist. Farming is actually not as easy as it used to be, though perhaps it is less laborious. There are more enemies to the crop than there used to be. These enemies are of two main sorts, living and lifeless: some are aerial, some terrestrial; some are seasonal and temporary, some are constant and cumulative. Yet these enemies are conquerable.

Complaint is made, in various parts of the country, that there is a decline in the fertility of the soil, that the soil is becoming "exhausted" by continued cropping. When the blame can be properly fixed on the soil itself, and not on faulty or no selection of seed, neglect in the sterilization of seed, neglect or ill-luck in the destruction of seed or seedlings by birds, gophers and other habitual vegetarians, it is generally found that neglect of some other sort explains the situation. The disc harrow instead of the deep plow, the filthy barn yard instead of well-manured fields, a change or no change of crops instead of crop rotation, and summer fallow instead of alternating grain and leguminous crops, these are some of the forms of neglect which I think I recognize.

If we speak of soil exhaustion now-a-days, we do not mean the actual depletion of the potassium and other salts, the sulphates, phosphates, nitrates; for no soil is so impoverished or so sterile as to lack these constituents completely, or even in such degree that they do not exceed the concentrations in the nutrient solutions commonly used in the laboratory with entire success. Ordinarily an exhausted soil is one in which plant excreta, by reason of faulty cultivation, have been allowed to accumulate. Sunning, airing, washing are the effective ways of cleaning soil as well as other things; but just as we may get the smell of tobacco smoke out of our clothes by walking them home, or otherwise using them in the open air, as well as by hanging them on the line, so soils can be cleansed at the same time that they are being used, if only the use be appropriate. This is crop rotation, an obviously more economical method than that of summer fallow, against which all nature rebels, but which is strangely popular in the west.

Important as the soil is—for no living organism can live without a minimum of mineral matter—I can not help feeling that the differences in the productiveness of great areas may be due to some other and more general cause than soil or season. The experiments of Klebs, Vöchting and others in the comparatively opaque atmosphere of Germany, the observations of Delpino in the clearer air of Italy, the records of John Muir and the impressions of all of us in California, and the work now

being done in the Carnegie Desert Laboratory at Tucson, Arizona, show that what we call fertility, attributing this to the soil, may after all be fecundity, a result to which light contributes at least as much as the soil. We may have luxuriant vegetative growth and no seed in rich but shaded soil; we do have scantier vegetative growth but abundant seeding in poor but brightly lighted spots. The development of the reproductive organs, the opening of the flowers, is one of the effects of light. Just as the light causes the orange yellow poppy blooms or the majenta corollas of Red Maids to open, so it is the light which stimulates the plants to form the blooms at all. And as we have more light in California than in many other parts of the world, so also we have richer and hence more stimulating light. The part played by richer light in the greater productiveness of certain large areas as compared with others will be more fully recognized presently than now. We should speak of fertile light and fertile air, if we are to recognize its importance as truthfully as we do that of the soil. And in selecting places for producing food, the world and its citizens will do well to take light as well as soil into account. The further study of light in relation to reproduction, to the setting of seed and fruit, and to the production of crop, will enable the world to increase its food supply without necessarily increasing its acreage.

Anything which disturbs the balance of nature releases forces, living and lifeless, which hitherto had been held in check. The complete change on the American Continent from a state of balance in the then wild nature to the present condition of cultivation, extending further and further into the wilderness, has resulted in so changing the conditions of existence that man and his parasites have enormously increased in numbers and the plants which he cultivates have been greatly multiplied and extended along with their insect, fungous and bacterial enemies. To meet this latter condition a profession is coming into existence similar to that which has thriven in consequence of the former. The plant pathologist, however, as his name implies, claims rather to be a student than a healer of disease. As fruit of his labors what is called preventive medicine in one profession has been developed in two very remarkable ways. The practise of sterilizing seed before sowing it has now become universal among intelligent and industrious farmers. By this simple means, great shrinkage in crop is measurably prevented. If sterilized seed is used, only subsequent infection can make trouble of microbic origin. Without yet understanding the basis of immunity, the United States Department of Agriculture and the State Agricultural Experiment Stations have succeeded in developing disease-resistant varieties of plants some of which are remarkably successful. We have, in these plants, instances of actually improved races, not merely "fancy" stock; stock capable of resisting specific forms of disease. Here is eugenics of

a sort worth while, a high ideal which is attainable, and an ideal which has been attained in certain instances.

By the labors, therefore, of plant pathologists, insect enemies are attacked and at least held in check, fungous and bacterial diseases are combated; indeed, to use a current expression of painful association, they are taxed "at the source" and often, like others, taxed out of existence. By these means crop production is increased and insured without increased acreage.

The relations of the plant pathologist and the public should be similar to those of physicians and the public. The plant pathologist owes it to the public to secure the best possible training before beginning practise, training which shall include a knowledge of disease of animal as well as vegetable origin, a knowledge of normal as well as morbid physiology. By combining entomology and botany the young man may assure himself both of more certain and better employment as plant pathologist, with corresponding increase in income, and also of greater usefulness, than if he devote himself from the beginning of his training exclusively to the study of insects or of plants.

The attitude of the public to the plant pathologist, on the other hand, is curiously different from its attitude toward the physician or surgeon whose care is human or other animal ills. The physician of good training and ability, with capital enough to escape starvation for a year or two, who settles where there are enough people may count on building up a private practise sufficient for comfortable support. The plant pathologist settling in a farming community and hanging out his shingle like doctor, dentist or veterinarian, would scarcely have a call. In relation to him the public is entirely socialistic. It expects him, if he is worth while, to be employed by the state; it is satisfied to have him so paid that only the missionary spirit or limited ambition and ability will take him into the profession; it is content with cheap advice even where so important a thing as crop, income, food even, is concerned. If it were not for interest in science, interest in out-of-doors, and for the missionary spirit, the public would not have received better advice in its struggles with plant disease than it paid for. The only part of the public which pays properly in times of trouble, when a plant doctor is needed, is the corporations causing the trouble!

We see, then, that the farmer must contend with enemies of many sorts, that he and his are subject to certain inconveniences incidental to delayed returns; but we see too that his career is not only useful, with the satisfactions of usefulness, it is self-supporting. If we wish to continue our parasitic existence in the present degree of comfort, we must encourage self support in others.

THE REINCARNATION OF JAMES EIGHTS, ANTARCTIC EXPLORER

By Dr. JOHN M. CLARKE

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IN the early days of the last century, when geography was yet young and there still remained some undiscovered nooks of the earth, the inquisitive merchant marine of our still younger and very saucy Yankee republic was finding its way into the farthest ports of the Seven Seas. The sails of the Ship of State had bellied with pride in the achievements of our canvas navy of 1812–1814, and the confident commercial enterprise which followed gave birth to a generation of agile shipmasters who recked as little of the terrors of the sea as does to-day the commander of the mightiest of our steel ocean machines. In these days before steam, the skippers of Stonington, New Bedford, New London—whalers in fact, but explorers in essence—became the pathfinders of the waters; searching their quarry in the Atlantic and Pacific, from the Arctic to the Antarctic. They never held back from cruising unknown waters in the hope of finding some new thing, and in some of these New England shipmasters grew up a fine sense of devotion to their country's credit. They sought out knowledge of foreign parts that their country might have the name and fame of discovery, and many a little brig with its stars and stripes roamed among the islands of the South Sea and into ports of the Orient, where to-day and long since the American colors are as rare as leviathans.

Edmund Fanning was one of these early Yankee venturers and one of the few who has left an account of his "seventy voyages" about the world in the years of his active life from 1792 to 1832. Fanning early became a shipmaster of the first class and, successful at that, as time passed he was a patron and promoter of voyages. America was the country of his adoption, and having adopted her he had pride in her progress and confidence in her future. If the young nation were to play her part with dignity she must do her share in the exploration of the unknown world, and, possessed of this theme, he had sufficient influence on the Congress to convince it of its duty to send out an exploring expedition over the southern seas, for down in those Antarctic latitudes where the American sealers were already finding rich fields were the mysterious Auroras, the mythical isles east of the Horn, of which returning vessels had brought enamouring tales.

So the Congress of 1812 decided upon a first official voyage of discovery into waters out of our control, and Fanning was commissioned

by President Madison commander of the two brigs *Volunteer* and *Hope*. The banner of hope was at the peak for a little while, but the same Congress soon pulled it down with a proclamation of war against Great Britain. Sixteen more years Fanning plied Congress with his project before it would again give heed to his plans for such a voyage of discovery, and in 1829 the shipmaster had grown too old to go to sea again; but early that year the United States Senate reported in favor of a South Sea expedition, and, though providing no money, it gave a moral support to the proposition and Captain Fanning was informally designated as "agent" of this first semi- or quasi-official "Voyage of Discovery." Fanning, filled with patriotic zeal, at once put two brigs into commission, the whalers and sealers, *Annawan,* Nathaniel B. Palmer, captain, and the *Seraph,* Benjamin Pendleton, captain and commander. These vessels sailed from Connecticut ports for the South Seas in October, 1829. On their return a report of the expedition made by Commander Pendleton to the "agent," Fanning, was transmitted to Congress and was published by its order. It is needless to add that such sentimental support "buttered no parsnips," so that the guarantors of the expedition had to seek their returns in seal oil and skins. More and worse than that, the commander in his report poured forth a tale of lamentations over what he thought was the failure of the expedition, excused its seeming shortcomings by stories of disease, dissension and almost mutiny among his crews, and it is hard to believe that Congress could find anything in such a calamitous tale to be worth printing at the public expense.

This is my introduction to the forgotten story of the brief scientific career of James Eights, of Albany.

It is an odd name, that of Eights, and it seems to be entirely extinct to-day in the region that knew it best. There is a tradition (perhaps nothing more) that the name was originally Van der Achten, which translated means *of more than one eight,* in other words, *Eights.* This seems rather far fetched and the name as it appears in the records of the Dutch families of Manhattan is Eght or Echt. It was not at all the practise of the Hudson valley Dutch to translate their surnames, after the manner of the French Canadians in America; but, at all events, the family stock was from Holland several generations before the birth of the scion whose name we desire to rescue from oblivion.

James Eights was the son of Dr. Jonathan Eights, in his day a well-known physician in Albany, and Jonathan was the son of Abraham, whose obvious piety won for him among his town folk the sobriquet of "Father" Eights. The specified qualities of sire and grandsire seem not to have descended far. James was born in Albany in 1798 in his father's fine Dutch house, which stood at the corner of North Pearl and Columbia streets, just opposite what is now the Kenmore Hotel, in the heart of the city's business district. A century ago this was the

center of old Dutch residence. Thereabouts were the Douws, the Terwilligers, the Huns, the Van Schaicks and Van Vechtens, the Ten Broecks and Ten Eycks, the Zerbrugges and the widow Visscher, and it was among the streets of the old town, still lined with its picturesque high-peaked houses, that young Eights got strong impressions of his environment. I say this because, if there is any memory of Eights in the town of his birth, it is of him as the artist who drew a series of color sketches of the streets of old "Albany in 1805"—pictures which have been copied so often that some of them are quite likely to be found in the homes of most of the old families. This skill with pencil and brush Eights developed very early and I am assured by one of his contemporaries, Mr. Albert Lawtenslager, now a man ninety-four years old, that these pictures were made while Eights was still a lad, though the very early date "1805" implies a memory or a tradition of houses and streets.[1]

I must say here that the records of the whole long life of James Eights are so particularly fragmentary that a diligent search has resulted in a mere matter of shreds and patches. Obviously the young man was possessed by a strong love of nature. How he indulged and promoted it we do not know, but may believe that, with the books he could get and the help he could draw from others, he was his own guide

[1] As a literary curiosity evincing a treacherous poetic license in dealing with prosaic facts of history, the inquisitive reader may be interested in a prettily written account of "Albany Fifty Years Ago" which appeared anonymously in *Harper's Magazine* for 1857 (Vol. XIV.), abundantly illustrated with woodcuts of the streets of Old Albany and with word pictures of its residents. These woodcuts were all copies of the sketches made long before by Eights, though no reference is made to the fact. It is not a very honest story for the anonymous writer begins it: "I am an Albany Knickerbocker—a Dutchman of the purest Belgic stock"—and he was nothing of the sort—and then he describes himself as a silver-haired man of eighty not many years away from his queue and cocked hat; while he was actually in his sunny forties and had little if any knowledge of the scenes he represented. Looking under the woodcuts one sees the imprint "Lossing and Barritt" and looking again into the list of authors of such unsigned articles published some years later, finds this author's name—Benson J. Lossing. The distinguished historian and engraver was not a citizen of Albany, not a Knickerbocker, but a Quaker with a little Holland blood, and he should at least have given credit to Eights for his attractive pictures. But Eights was pillaged all his life and that is one reason why he got "lost." So Lossing's stories of the old residents and their homes in 1805 must have been, in large measure, hearsay, and he seems to have got rather mixed about the Eights family for he assigns a high gabled house up North Pearl street a few doors beyond "Webster's Corner" (State and Pearl) to William Eights who is said by him to have been driven from New York in 1776, after the British occupation, because of his Whig sentiments. There never was but one Eights family in Albany and the head of it then was Abraham Eights. He doubtless came from New York and he may perhaps have lived in this house, but if he did his son, Dr. Jonathan, built the house we have referred to far up the street near the Fox Kill.

and master in his study of the rocks, the plants and the animals about his home, in all of which we know he was deeply interested. What he had of the schools seems to have been only from those of his own town, but when he came to the time of fixing his career in life, he naturally turned to medicine; it was his father's, it should be his, and it afforded a better chance of close touch with natural history than any other. And so perhaps for this reason James Eights became a physician.

He was to be now known through life as Doctor Eights, but he seems never to have practised medicine. It is here, along through the years of his young manhood, that there is neither record nor story, and it is not till the event of the Fanning voyage that this unwilling escupalian cut the first and almost only notch in the tally stick of his real career. Through influences we do not know but which were a testimony of his recognized ability in natural history, he was appointed naturalist to the "Exploring Expedition of 1830," that first United States voyage of discovery. There is not a word in any record left by him or his shipmates that indicates whether he sailed on the *Seraph* or the *Annawan*, but the two brigs seem to have kept together and shared their troubles. Indeed, so far as I can find, his name was never mentioned in any record as a member of this scientific company by any one except Captain Fanning and Eights himself.

As I write now of Doctor Eights's admission to quasi-official scientific service on this cruise of discovery, I call to mind the characterization of the man by my chief and Eights's contemporary, Professor James Hall, the distinguished geologist of New York from 1836 to 1898, who frequently spoke to me of his high regard for Eights's extraordinary scientific talents. He must have had a very close touch with all the natural science of his day, however he got it, for this is evident in the technical reports of his explorations and his subsequent writings.

Congress had "approved" this expedition in June, 1829, and the two brigs left New London in October, headed straight for the Antarctic, but with orders to meet at Staaten Island in case they got separated on the way. Directly they left the home port they did lose each other, and neither saw its consort till the distant island was reached. Staaten Island lies at 55° just off the east point of Fuego. It is an island that has figured often in the experiences of the explorers, for, barren spot as it is, it lay on the Cape Horn course and was a point of departure for the short and sharp attack on the seals of the Antarctic ice front. Thence one of the boats, probably the *Annawan*, but perhaps both, put out for the South Shetland Islands—those remote spots of whose enormous supply of seals abundant evidence had come by the American whaling fleet and had beyond doubt helped to substantiate this expedition. Now in this year 1829 what was known of these South Shetland Islands is the following:

Students of southern explorations seem to have little doubt that the

first to see them was Dirck Gerritse, whose good ship *De Blyde Boodschap* in 1599 was driven by a gale far to the south of Magellan when her captain sighted in the distance the tops of some snow-clad mountains. In itself this record was of much the same worth as the discovery of "Crocker-land." It is as equally certain that the first trustworthy knowledge of them came from the American sealers and whalers who had found them out as early as 1812. For years these American ships resorted thither, but no record of the new lands was laid down till the English skipper, Captain William Smith, observed them in 1819, made them out to be a chain of islands and called them the *New South Shetlands.* Fanning whimsically says:

> We Yankees might with more propriety after our rediscovery, claim them and name them *South Martha's Vineyard,* or something else.

Smith returned to Valparaiso, told his story to Captain Sheriff of the British frigate *Andromache,* and Sheriff detailed Lieutenant Bransfield to accompany Smith back to the islands, and they two are said to have determined the extent of the group. Gerritse, Smith and Bransfield all have their names perpetuated in the geography of the region—Dirck Gerritse Archipelago, Smith Island and Bransfield Strait. Fifteen months later came the Yankee brig *Hersilia,* Captain J. B. Sheffield, Nathaniel B. Palmer, mate, and they gave names to the individual islands from west eastward, but these have been ignored for the names of to-day.

Thus when the Yankee brig of 1829 with its scientific supercargo, Eights, aboard, picked up the islands only so little as has been indicated was known of them, and all that has been written since will barely enlarge our knowledge of them beyond that given by Dr. Eights in his *Remarks on the New South Shetland Islands,* communicated to the Albany Institute in 1833.[2] There is in this descriptive account a pleasing diction, and an effective phrasing, tinged by a kind of Wordsworthian

[2] *Transactions of the Albany Institute,* Vol. 2, p. 58. The full title is: "Description of a new Crustaceous Animal found on the Shores of the South Shetland Islands, with Remarks on their Natural History. By James Eights, Naturalist to the Exploring Expedition of 1830, and Corresponding Member of the Albany Institute."

The "Antarctic Manual," prepared for the use of the National Antarctic Expedition in 1901, by George Murray, with preface by Sir Clements Markham, contains a supposedly complete bibliography of the Antarctic, but there is, in a list of 878 titles, no single reference to Eights's papers nor to the expedition to which he was attached; neither to the *Annawan* or *Seraph,* the *Hersilia* or Sheffield, Captain N. B. Palmer, discoverer of Palmer's land in 1820, is confused with J. C. Palmer, whose title to fame seems to lie in a mariner's song written by him in 1868; Titian Peale, of the Wilkes Expedition, is called Titus Peale, and so on. Contemporary reviewers in American scientific and literary magazines ignored Eights entirely though steeping their pages with the work of other explorers (*vide, e. g., Silliman's Journal, Knickerbocker Magazine, North American Review*).

color, which clothes the rawness of the subject, quite too obviously exposed in the accounts of later writers. His sentences are worth reading, and in the light of new knowledge it is to be remembered that his descriptions, ignored by time, were written eighty-six years ago. To establish Eights in his true estate it is well to extract freely from his accounts of these islands.

Speaking generally of their physiography, he says:

> They are formed by an extensive cluster of rocks rising abruptly from the ocean, to a considerable height above its surface. Their true elevation can not easily be determined, in consequence of the heavy masses of snow which lie over them, concealing them almost entirely from the sight. Some of them, however, rear their glistening summits to an altitude of about three thousand feet, and when the heavens are free from clouds, imprint a sharp and well-defined outline upon the intense blueness of the sky: they are divided everywhere by straits and indented by deep bays, or coves, many of which afford to vessels a comfortable shelter from the rude gales to which these high latitudes are so subject. When the winds have ceased to blow and the ocean is at rest, nothing can exceed the beautiful clearness of the atmosphere in these elevated regions. The numerous furrows and ravines which everywhere impress the snowy acclivity of the hills are distinctly visible for fifty or sixty miles, and the various sea-fowl, resting upon the slight eminences and brought in strong relief against the sky, ofttimes deceive the experienced eye of the mariner by having their puny dimensions magnified in size to those of the human form.
>
> The sun, even at midsummer, attains but a moderate altitude in these dreary regions, and when its horizontal beams illumine these masses of ice, their numerous angles and indentions catching the light as they move along, exhibit all the beautiful gradations of color from an emerald green to that of the finest blue. Some of them whose sloping sides will admit of their ascent, are tenanted by large assemblages of penguins, whose chattering noise may be heard on a still day at an incredible distance over the clear smooth surface of the sea. When the storms rage and the ocean rolls its mountain wave against their slippery sides, the scene is truly sublime. Tall columns of spray shooting up far above their tops, soon become dissipated in clouds of misty white; gradually descending, they envelope the whole mass for a short space of time, giving to it much the appearance of being covered with a veil of silvery gauze. When thus agitated they not unfrequently explode with the noise of thunder, scattering their fragments far and wide over the surrounding surface of the deep.
>
> The sky too in these latitudes presents a very singular aspect; being most generally filled with innumerable clouds, torn into ragged and irregular patches by the wild gales which everywhere race over the Antarctic seas; the sun as it rises or sets, slowly and obliquely in the southern horizon, sends its rays through the many openings between, tingeing them here and there with every variety of hue and color, from whence they are thrown in mild and and beautiful reflections upon the extensive fields of snow which lie piled on the surrounding hills, giving to the whole scene for a greater part of the long summer day, the ever varying effect of a most gorgeous sunset.

This is certainly a toothsome and pictorial dressing for the bare bones of the Antarctic, which challenges only an artist's palette.

It is worth while taking note of Eights's geological observations. The reader should bear in mind that they were the first ever made in

the Antarctic and were put down by a man who was in his time reckoned a geologist.

The geological features that these islands present in those highly favored situations, where the continuous power of the winds has swept bare the rocks, correspond in a great measure with their desolate and dreary aspect. They are composed principally of vertical columns of basalt, resting upon strata of argillaceous conglomerate; the pillars are united in detached groups, having at their bases sloping banks constructed of materials which are constantly accumulating by fragments from above. These groups rise abruptly from the irregularly elevated plains, over whose surface they are scattered here and there, presenting an appearance to the eye not unlike some old castle crumbling into ruin, and when situated upon the sandstone promontories that occasionally jut out into the sea, they tower aloft in solitary grandeur over its foaming waves; sometimes they may be seen piercing the superincumbent snow, powerfully contrasting their deep murky hues with its spotless purity. Ponds of fresh water are now and then found on the plains, but they do not owe their origin to springs, being formed by the melting of the snow. . . .

A few rounded pieces of granite are occasionally to be seen lying about, brought unquestionably by the icebergs from their parent hills on some far more southern land, as we saw no rocks of this nature *in situ* on these islands. In one instance, I obtained a boulder nearly a foot in diameter from one of these floating hills. The action of the waves has produced little or no effect upon the basalt along this coast, as its angles retain all the acuteness of a recent fracture, but when the conglomerate predominates, the mass is generally rounded.

The color of the basalt is generally of a greenish black. The prisms are from four to nine sided, most commonly however of but six, and from three to four feet in diameter; their greatest length in an upright position above the subjacent conglomerate is about eighty feet. Their external surfaces are closely applied to each other, though but slightly united, consequently they are continually falling out by the extensive power of the congealing water among its fissures.

Clusters of these columns are occasionally seen reposing on their side in such a manner as to exhibit the surfaces of their base distinctly, which is rough and vesicular. When this is the case they are generally bent, forming quite an arch with the horizon. When they approach the conglomerate for ten or twelve feet, they lose their columnar structure and assume the appearance of a dark-colored flinty slate, breaking readily into irregular rhombic fragments; this fine variety in descending, gradually changes to a greenish color and a much coarser structure, until it passes into a most perfect amygdaloid, the cavities being chiefly filled with quartz, amethyst and chalcedony. . . . The effect produced upon it by the action of the file is very slight; the steel elicits no sparks; the fragments are angular with an imperfect conchoidal fracture; its structure is coarsely granular and uneven, and is composed essentially of hornblende, feldspar and a greenish substance in grains much resembling epidote; crystals of leucite of a yellow and reddish tinge are disseminated throughout the mass whose fractured surfaces strongly reflect the rays of light to the eye; in some places it sensibly affects the needle, owing no doubt to its iron. Veins of quartz frequently traverse the fine variety, some of them containing beautiful amethysts.

The basis rock of these islands, as far as I could discover, is the conglomerate which underlies the basalt. It is composed most generally of two or three layers, about five feet in thickness each, resting one on the other and dipping to the southeast at an angle of from twelve to twenty degrees. These layers are di-

vided by regular fissures into large rhombic tables, many of which appear to have recently fallen out, and now lie scattered all over the sloping sides of the hills, so that the strata when seen cropping out from beneath the basalt present a slightly arched row of angular projections of some considerable magnitude and extent.

The upper portion of this conglomerate for a few feet is of a dirty green color, and appears to be constructed by the passage of the amygdaloid into this rock, the greenish fragments predominating, and they are united to each other principally by zeolite of a beautiful light red, or orange color, together with some quartz and chalcedony.

The minerals embraced in this rock are generally confined to its upper part, where it unites and passes into the incumbent amygdaloid; many of them are also in common with that rock. They consist chiefly of quartz, crystalline and amorphous, amethyst, chalcedony, cachalong, agate, red jasper, felspar, zeolite, calcareous spar in rhombic crystals, sulphate of barytes, a minute crystal resembling black spinelle, sulphuret of iron and green carbonate of copper.

The only appearance of an organized remain that I anywhere saw was a fragment of carbonized wood imbedded in this conglomerate. It was in a vertical position, about two and a half feet in length and four inches in diameter: its color is black, exhibiting a fine ligneous structure, the concentric circles are distinctly visible on its superior end, it occasionally gives sparks with steel, and effervesces slightly in nitric acid.

In this very detailed account of the columnar basalts with the sandstone conglomerate into which they are intruded, and the metamorphism of the contact zone, Eights first laid hold of structures which have been recorded again by later observers. The sandstones seem to be the same as that called by Ferrar of the *Discovery* the "Beacon sandstone" which with its volcanic sills covers great areas of South Victoria Land. Debenham of the Scott Expedition has written of them. In 1892 Larsen at Seymour Island just east of Graham Land, found fossils, the first, says Nordenskiold and after him Amundsen, winner of the South Pole, ever taken in the Antarctic. But here was Eights more than 60 years before, knocking out fossil wood from the sandstones of the South Shetlands—wood which, in more than remote probability, pointed toward that mysterious Gondwana Land which has been thought to have bound Antarctic America to the Orient during the most of its geological history. Shackelton found seams of coal and fossil wood in this Beacon sandstone, of which Schetelig says, "this belongs to the Upper Devonian or Lower Carboniferous." Now with the richness of fossil life recently brought home by Andersson and Nordenskiold, Amundsen, Shackelton and the men of Scott, let us acknowledge the keen-eyed record and the intelligent interpretations of the Albany naturalist.

Eights was among the first observers to make record of the active volcanoes in the vicinity of these islands, and what was then called Palmer's Land—the land, which passing down the years with various designations, has slipped first its American hawser and then its French (Louis Philippe Land), to tie up at last with an Englishman, Graham.

He saw and took note of that remarkable half-submerged crater, Deception Island, soon to be much more fully described by the Englishman, Foster, a year or two later.

To the botanical species listed by Eights as composing the flora of these islands, later years may have brought some additions. Of this I can not be sure, but he says:

> The *Usnea fasciata* Torrey is most common. A species of *Polytrichum* resembling the *alpinum* of Lin., one or two lichens and a fucus found in the sea along the shores—when you add to these an occasional plant of a small species of *avena*, you complete the botanical catalogue of the islands.

Then, in his picturesque way, Eights takes up for description the water mammals, the sea-elephant (*Phoca leonina;* I am using his designations), the sea-leopard, the fur seal (*P. vitulina*).

> There is also a fourth species, which I have no recollection of ever seeing the slightest notice of. It is probably not common, as I saw but one; it was standing on the extremities of its fore-feet (flippers), the head and chest perfectly erect, abdomen curved and resting on the ground, the tail was also in an upright position; the animal in this attitude bore a striking resemblance to the representations we frequently meet with of the "mermaid," and I think it was undoubtedly one of the animals of this genus that first gave origin to the fable of the maid of the sea. I regret that I could not obtain a nearer view of this interesting animal. When I approached within one hundred feet, it threw itself flat and made rapidly for the sea: it appeared about twelve or fifteen feet in length, and distinctly more slender in proportion than any of the other species, so much so that the motion of the body when moving seemed perfectly undulating. Some of the seamen had seen them frequently on a former voyage, and mentioned that they were known among sealers by the name of sea-serpent, from this circumstance. Some of the teeth were brought to me which had been picked up on the beach. The crown of the grinders is deeply and singularly five lobed.
>
> When these [other] animals resort to the shores for the purpose of breeding or shedding their hair, they are in fine condition. During this time they require no food, existing by the absorption of their fatty matter: if killed at this period, you generally find a quantity of small stones in the stomach, swallowed most probably for the purpose of keeping that organ distended and preventing its internal surfaces from adhering to each other. When the season for returning to the sea arrives, these stones are ejected on the beach, and they proceed in search of their ordinary food, which is chiefly penguins. A singular character in the habit of these animals is the faculty they possess of shedding tears when in any way molested. The eyes becoming suffused and the large tear-drops chasing each other in quick succession over their wrinkled faces, creates quite a sympathy in the breast of the beholder.

He also describes the fin whale (*Balæna physalis*), right whale (*B. mysticus*), the grampus, dolphin and porpoise—perhaps a fairly complete statement of this fauna as now known, though they are now traveling under somewhat different names.

In present days great interest has attached to the birds of these latitudes, and pretty tales of the whimsical Antarctic penguins have been the delight of several recent writers. Let us see what Eights had to say of them in 1830:

The *Aptenodytes patagonica*, Gm. (king penguin) is the largest and by far the most beautiful of the species, and may be seen in great numbers covering the shores for some considerable extent. They are remarkably clean in their appearance, not a speck of any kind is suffered for a moment to sully the pure whiteness of the principal part of their plumage: their upright position, uniform cleanliness, and beautiful golden yellow cravat, contrasts finely with the dark background by which they are relieved, so that the similitude is no unapt one, which compares them to a regiment of soldiers immediately after parade. The females lay but one egg on the bare ground, which is rather larger than that of a goose, and of about equal value as an article of food, but differs a little in shape, being more tapering at its smaller end. The egg lies between the feet, the tail being sufficiently long to conceal it effectually from the sight. When approached they move from you with a waddling gait, rolling it along over the smooth surface of the ground, so that a person not acquainted with the fact might pass through hundreds of them without discovering it. The *Spheniscus antarcticus* Shaw (rookery penguin), is more numerous than any of the other species, assembling together in vast congregations, occupying the smooth strips of plain for a mile or more in extent; passing through them, they barely give you sufficient space, picking at your legs, and keeping up a continual chatter. Their whole appearance as you walk along brings powerfully to your recollection the story of Gulliver, striding among the Lilliputians.

Sixteen other species of birds are mentioned by him in their Latin dress. And then, first again in this field, he mentions the Mollusca—three species, a *Pholas*, a *Nucula* and a *Patella*, all new to science, he thought.

This account of the South Shetlands was perhaps Dr. Eights's most notable contribution to science, but it was rather general and did not represent the total outcome of his investigations. In connection with it, in the *Transactions of the Albany Institute*, he described[3] under the name *Brongniartia trilobitoides* a crustacean of which he says:

I was convinced that [it] came nearer to the long lost family of Trilobites than anything hitherto discovered.

Amos Eaton, the distinguished teacher and Eights's friend, had the same conviction, for he says of this creature[4] when describing the trilobite genus *Brongniartia* (a name of his own contrivance):

It is my opinion that Dr. Eights has specimens of two distinct species of this genus which he collected in the southern ocean.

Eights thought that the species of Eaton's genus belonged to genera already employed by Jacob Green and DeKay, and so in the mutual scramble to honor Alexander Brongniart, he appropriated the word *Brongniartia* for his "living trilobite." Eights's drawings of his crustacean are beautifully effective and detailed and to aid in its illumination he adds a picture of the Silurian trilobite *Lichas Boltoni*. The living trilobite waited seventy years for rediscovery. Mr. Hodgson, reporting

3 As cited above.

4 "Geological Textbook," 2d ed., 1832.

for the "Discovery" Expedition, describes and figures it under the name of *Serolis trilobitoides.*

In another paper, a year or two later, but printed in the same volume of the Albany Institute's *Transactions,* Eights describes another strange crustacean,[5] illuminated by two exquisite plates. This is his *Glyptonotus antarctica,* an isopod-looking creature, of which its finder, still impressed by his acquaintance with New York State fossils, remarks:

> This beautiful crustacean furnishes to us another close approximation to the long-lost family of the Trilobite.

Doctor Chilton of Christchurch, New Zealand, informs me that this crustacean was found by the German Transit of Venus Expedition to South Georgia in 1882–3 and was redescribed by Pfeffer in 1887. "It does not," he says, "seem to have been collected by the more recent English, French and German Antarctic expeditions." Doctor Chilton thinks that the species is among the specimens brought home by the Scottish Antarctic Expedition.

Still a third paper with other fine drawings was published by him in 1837 in the first volume of the *Journal of the Boston Society of Natural History,*[6] and gave an account of *Decolopoda australis,* an unbelievable ten-legged pycnogonid, the first thing of its kind. Dr. Leon J. Cole, writing to me from Cambridge some years ago, says of this:

> A ten-legged pycnogonid such as *Decolopoda* was an unheard of thing until Eights described this one, and for some reason his discovery appears never to have come to the attention of students of the group, for nowhere, so far as I have been able to find in the writings since his paper was published, has mention been made of the remarkable fact. When I looked up Eights's paper a year or two ago I thought at first that a mistake had been made in the drawing and one too many pairs of legs put on the animal. . . . I was not so much surprised as I should otherwise have been when a paper appeared this winter (1905) by Mr. J. V. Hodgson, naturalist on the *Discovery,* describing a ten-legged pycnogonid taken by the National Antarctic Expedition in McMurdo Bay, the ship's winter quarters. Mr. Hodgson named his form *Pentanymphon* and says that the presence of a fifth pair of legs is a "character which separates it from all the Pycnogonids hitherto known." . . . I then wrote to Mr. Hodgson calling his attention to Eights's paper, which it appears had been brought to his notice in the meantime, and in reply he informs me that among the Pycnogonida collected by the Scottish Antarctic Expedition he has found specimens which agree in all essentials with those described so long ago by Eights.

A more recent letter from Dr. Cole from Madison (1915) says that the Scottish Expedition found fifteen specimens of Eights's species in Scotia Bay, South Orkneys, and the French Expedition another species of this genus.

[5] "Of a New Animal Belonging to the Crustacea Discovered in the Antarctic Sea."

[6] "Description of a New Animal Belonging to the Arachnides of Latreille; Discovered in the Sea along the Shores of the New South Shetland Islands," p. 203.

The "Voyage of Discovery" and its results were after all a matter of no slender record, and Eights's hours seem now to have become of rather idle and impecunious ease. In the years from 1835 to 1840 he wrote anonymously for the *Zodiac,* an Albany magazine of distinctly cultural pretension, articles on the flowers, clouds, weather, insects, birds, mollusca, geology, the lowering of the Hudson River, elevated beaches, turtles, sun-spots, fossils, minerals, constellations, all local observations of a well-stocked mind belonging to an out-of-doors man and naturalist. Somewhere about this time or earlier he must have invented the name "Cocktail" or "Cauda-galli grit" for one of the New York geological formations. It was a name that came into general use and was ascribed to Eights by the official geologists of the state who adopted and continued to use it till it was displaced by the present substitute, "Esopus grit."

But during these years other things were brewing in the line of exploring expeditions. On the Fanning expedition with Eights, as a member of the scientific corps, had been John N. Reynolds. Reynolds was not a man of science, but a landsman from the Middle West to whom the ancient call of the sea was invincible. Of him and his associates Captain Fanning says, in writing to the Secretary of the Navy, Mahlon Dickerson (1836):

> Mr. Reynolds having been one of the individuals in the little American Exploring Expedition (the first patronized by government) of the brigs *Seraph* and *Annawan,* etc., . . . two of the gentlemen companions of the voyage, Messrs. John Frampton Watson, of Philadelphia, and James Eights, of Albany. These are profound scientific men.

To Reynolds has been given the credit of initiating the sentiment and leading the campaign which resulted in the organization of the Wilkes Exploring Expedition. "The father of this project was John N. Reynolds," said President Gilman in his "Life of James Dwight Dana," and at some length he refers to Reynolds's vigorous propaganda on its behalf, both before and outside of Congress. But, says Secretary Dickerson to Captain Thomas Ap Catesby Jones (who had been first selected to command the proposed expedition) in a letter of 1836:

> Captain Fanning long since proposed a South Sea exploring expedition and has been urging it ever since. Ever since the administration of Mr. Madison, so far as there is merit in originating and urging, this measure is due to Captain Fanning.

On this new expedition Eights wanted to go, and his experience was beyond doubt reasonable guaranty of his fitness. And as the plans grew, he filed with the Secretary of the Navy his application for appointment as *geologist.* Besides his experience afloat and ashore, he had the endorsement of Professor John Torrey, the eminent botanist, and doubtless of Captain Fanning, and he was duly appointed by Secretary

Dickerson, of which appointment he makes acknowledgment in June, 1837. Then, two months after, the appointees of the scientific corps got together in Philadelphia and fixed up their assignments. Reynolds, who was most active in organizing the supercargo, did not want Eights at all; Torrey had written to Dickerson that he never intended to recommend Eights as geologist; he and all the rest wanted Dana for mineralogist and geologist and Eights for zoologist, and when the men themselves met to determine their assignments (this was left by the Secretary to their own discretion) Eights withdrew his choice and contented himself with the field of "organic remains." Eights's appointment was notified to Congress by the Secretary, he was permitted to buy his equipment including $300 worth of books, and he received pay in advance of sailing until the appropriation was exhausted. But nevertheless, for reasons which appear on no records that I have been able to find or that have ever been referred to, Eights was omitted in the final make-up of the corps of scientific men. He was not alone in this mishap and others who suffered with him joined later in an appeal to Congress for remuneration for wasted time and service.

What brought about this elimination of Eights from the Wilkes Expedition there is none left to tell. To have had his functions restricted by his colleagues to that of paleontologist of a marine expedition seems a reduction to the lowest terms, dangerously close to an elimination, which lay beyond their power. And yet Dana, for whom Eights allowed himself to be effaced, went as "mineralogist" and came back as a zoologist of high distinction. Perhaps Eights, with his experience and versatility, might have done as well, but the American Philosophical Society, in responding to a request of the Secretary of the Navy for a plan of organization of the scientific corps, did not include a paleontologist, and we have just observed that Mr. Reynolds, who was clothed with no small authority in this matter of composing the personnel of the corps, did not approach or recommend Eights. Wherever the cause lay, in disaffection acquired by Reynolds for Eights while on their trip to the Antarctic, in the thinly veiled jealousies common to scientific men of the time,[7] or perhaps in Eights's personal habits, this crushing of his hopes was the downfall of his career. Whatever justification the Secretary of the Navy may have found for his final action in the case, Eights from this time on ceased to live; though he remained on earth for nearly a half century longer.

The rest of the story is short. There are no records of Albany that

[7] As a notable example of the bumptious democracy of the time, the series of anonymous letters publicly addressed by J. N. Reynolds to Secretary Dickerson on the subject of the expedition, are hardly to be surpassed for personal indelicacy, disrespect for high place and rudeness of address, and they were assembled and printed by their author over his own name.

tell of Eights's activities during the years that followed. Only the directories show his occasional presence up to 1853. In his contributions to the *Zodiac* there are passages which show a rather intimate acquaintance with Indian customs and life, and Mr. Lawtenslager has intimated that after the sailing of Captain Wilkes, Eights did go out among the western tribes, but if under government auspices I have found no record of it. In 1853 his name appears for the last time in the Albany directory, where he is entered as "draughtsman and geologist." There is no evidence among the very full documents in my possession relating to the Geological Survey that Eights had any official connection with it, and I fancy this title means that he was doing drawing and geology for Dr. Ebenezer Emmons for his *geological* reports on the agriculture of New York. These were days when the Taconic controversy was hot and Emmons's "Taconic system" was struggling for life. Emmons was writing his full exposition of it for his "Agriculture of New York," and his colleagues during the days of the first State Geological Survey (1836–42) had vigorously antagonized the entire proposition. Ebenezer Emmons, Jr., who knew Eights as his father's friend, has told me that Eights had sympathized with and stood by the elder Emmons in these contentions and no such man could have gained employment from the New York State Geologist of 1853. In 1852 Eights published a paper in the *Transactions of the Albany Institute* on the surficial geology of Albany.[9] It contains much that is interesting even to-day regarding the composition and hydrology of the sands and clays of old Lake Albany and gives one of the earliest illustrations of the disrupted clay strata broken into by dragging icebergs.

This is Dr. Eights's last appearance, and of what remained of his life little is to be said further, or little known, and even that is hardly worth the telling. Mr. Lawtenslager, who came to Albany in 1848 and started in business on State Street just below Green, tells me that in the 50's he and Eights had rooms together there. Eights was unmarried and alone, and he was poor—so poor, indeed, that it is clear to me from the very guarded statements of his old companion, that the friendship of the two meant subsistence for one. I have heard, too, of another great disappointment in his life—one that turned his heart sour and kept him a bachelor. So his sands ran on—he had lost his grip—through the sixties and into the seventies; he was an old man now and in his growing feebleness he sought the home of a sister living in Ballston, and there died in 1882, eighty-four years old.

James Eights left his mark—and now let us judge of the size of Hercules from his foot.

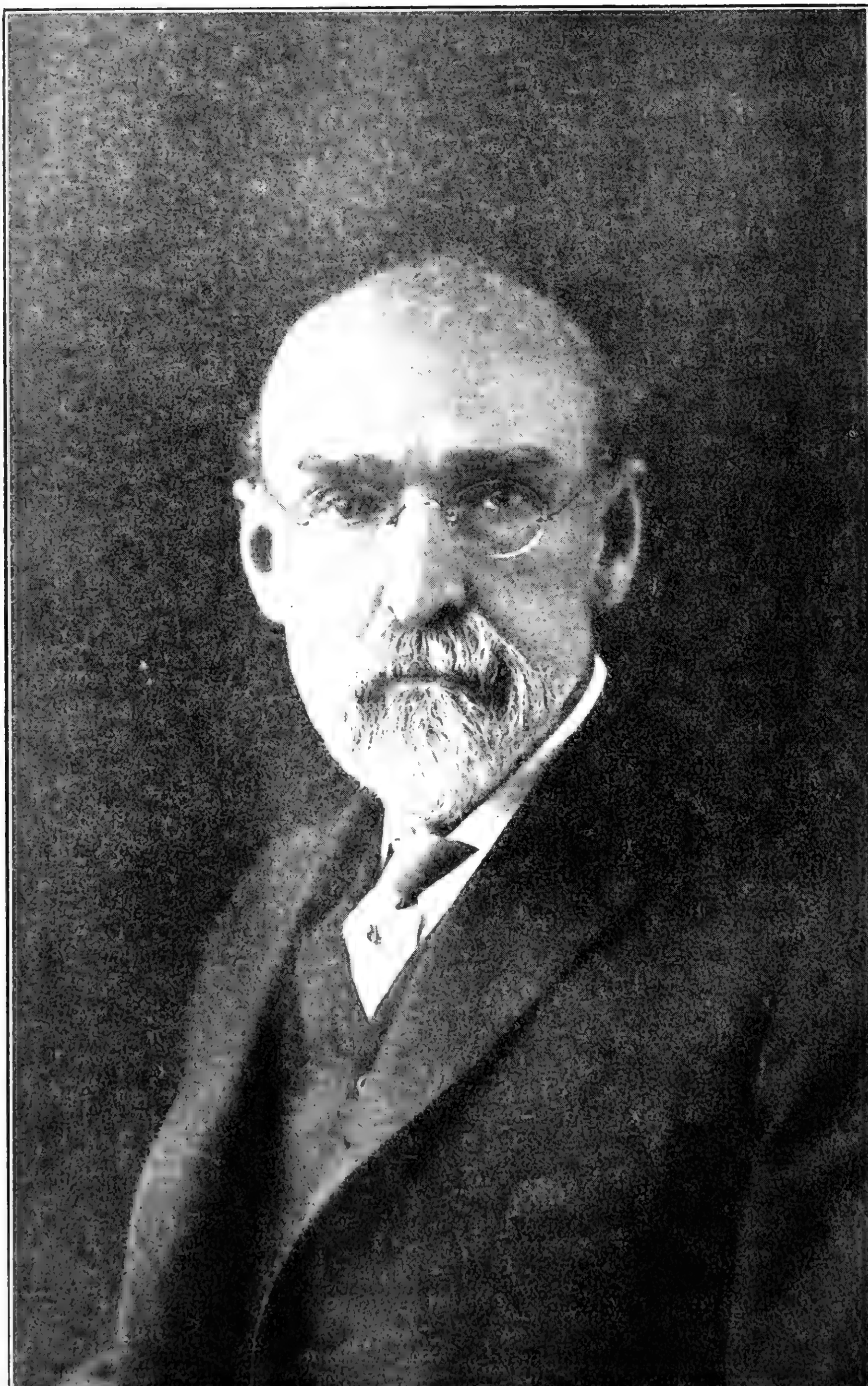
[9] "Observations on the Geological Features of the Post Tertiary Formation of the City of Albany and Its Vicinity" (Vol. 2).

THE PROGRESS OF SCIENCE

THE COLUMBUS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Although there was this year a wide dispersal of scientific societies with some conflict in their meetings, the scientific men of the country have become so numerous that it is possible to conduct a number of simultaneous meetings, each of which has a larger attendance and a more important program than would have been possible for all the scientific interests of the country to arrange twenty-five or thirty years ago. Thus the attendance at Columbus was in the neighborhood of one thousand. At the Pan-American Scientific Congress in Washington the attendance was about the same, although there the natural and exact sciences did not dominate the program or the situation. In Boston, however, there was an excellent meeting of physiologists and men working in related lines with a program of some three hundred papers. The anatomists at New Haven and the psychologists at Chicago also had well-attended meetings.

On the Grounds of the Ohio State University. The spring with the Library in the distance.



Dr. Charles R. Van Hise,

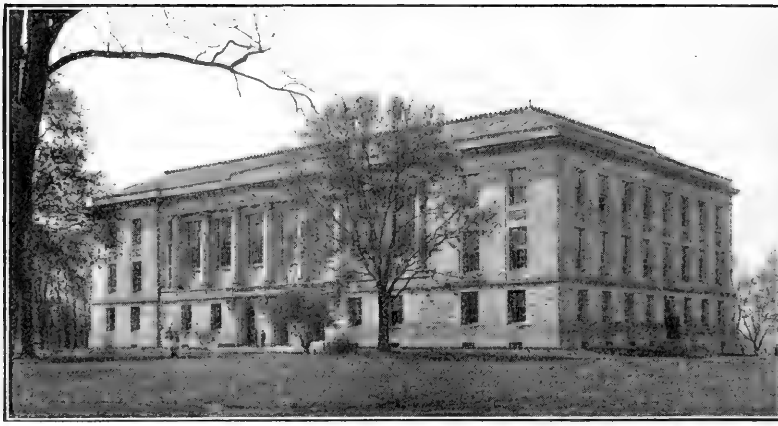
President of the American Association for the Advancement of Science.

At the Ohio State University the American Association met in its twelve sections and in affiliation with some fifteen special national societies, including those devoted to mathematics, physics, zoology, entomology and botany. The opening meeting completely filled the college chapel, seating about twelve hundred persons. The address of welcome, by President W. O. Thompson, of the university, and Dr. T. C. Mendenhall, past-president of the association, were extremely happy. Dr. Thompson welcomed the association on the part of the university, city and the commonwealth, and Dr. Mendenhall, finding that his predecessor had included practically all of Ohio in his address, welcomed the association on the part of the shades of deceased Ohio men of science, sketching briefly the career of a number of Ohio's great men of science of the past century. President Eliot's address entitled "The Fruits, Prospects and Lessons of Recent Biological Science" was published in the issue of *Science* for January 7.

It points out that up to a hundred years ago the principal applications of science were of physics and chemistry, and that, while these had vast economic value, the good was mixed with evil, as in the development of the factory system and the congestion of population in cities. It was claimed that during the past hundred years, biological science has contributed most to the well-being of humanity, and that its service had been direct and entirely beneficent. Those who heard Dr. Eliot's admirable address will be inclined to agree with a remark recently made by a leading professor at Harvard that the only serious error Dr. Eliot had made in his life was retiring from the presidency of the university at the age of seventy-five.

There were three public lectures complimentary to the citizens of Columbus given by Professor Douglas W. Johnson, of Columbia University, on "Surface Features of Europe as a Factor in the War"; Dr. Raymond F. Bacon, director of the Mellon Institute of Pittsburgh, on "The Industrial Fellowships of the Mellon Institute: Five Years' Progress in a System of Industrial Service," and Dr. Frank K. Cameron, of the Bureau of Soils, Washington, on "The Fertilizer Resources of the United States." Then there were

UNIVERSITY HALL.



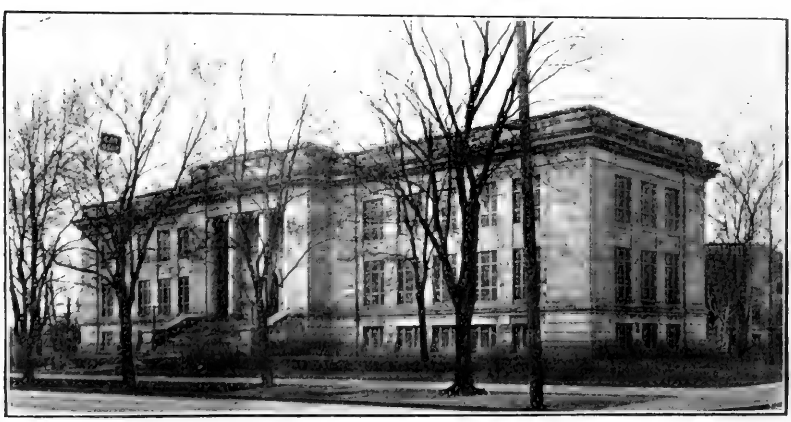
THE LIBRARY.

the addresses before the sections and the special societies and a large number of discussions and programs of general interest, as well as the long series of special papers in the different sections covering the research work accomplished during the year.

Dr. W. W. Campbell, director of the Lick Observatory, who presided at Columbus, gave an evening address on "The Evolution of the Stars" at a special meeting of the association called in Washington the following week as a compliment to the Pan-American Scientific Congress. As his successor in the presidency of the association, the highest honor annually conferred on an American man of science, Dr. Charles R. Van Hise, was elected. Dr. Van Hise, who as professor of geology has attained scientific eminence by his contributions to structural geology and ore-deposits, has recently been active in the plans for the conservation of natural resources, and as president of the University of Wisconsin for the past thirteen years has been the leader in the movement to make the university a dominant factor in the state.

THE OHIO STATE UNIVERSITY

THE Ohio State University is at the gateway between the Atlantic states and



THE ARCHEOLOGICAL AND HISTORICAL MUSEUM.

CHEMISTRY HALL.

the north central states. On one side the private universities and colleges predominate, on the other, state supported institutions. Two years ago, there were 129,000 students in the private institutions for higher education in the United States, while there were 88,000 in our public institutions. In the North Atlantic division there were about 60,000 students in the private institutions and 8,000 in the public institutions, whereas in the North Central division there were 41,000 in the one and 44,000 in the other. The Ohio State University, owing to its situation and to the private universities of the state, was one of the last to take its place among the great state universities. It is also the case that in Ohio there are two other state-supported universities, Ohio University and Miami University, while the University of Cincinnati is the leading city-supported institution of the country.

The Ohio Agricultural and Mechanical College was one of the land grant institutions established under an act approved by President Lincoln in 1862. It was not, however, chartered by the legislature until 1870, and was opened for the reception of students only in 1873. In 1878 the name was changed to the Ohio State University. When the American Association met in Columbus in 1899 the institution was well established, but the growth that has taken place in the intervening years is

BOTANY AND ZOOLOGY BUILDING.

OHIO UNION, THE STUDENT BUILDING.

remarkable. The old university hall, typical of the college architecture of the last generation, is now surrounded by a group of fine modern buildings and laboratories, including the library built in 1912 at a cost of $300,000 and the archeological and historical museum, opened a year later. The Ohio Union has been erected at a cost of about $100,000, as a social center for student activities, and there is a series of buildings for the different sciences, including physics, chemistry, botany and zoology, horticulture and forestry and other agricultural departments.

All the colleges and departments of a modern university are included in the organization. There are, indeed, some schools not always found, such as colleges of education, pharmacy and dentistry, and there has recently been organized a college of commerce. Apart from the summer session, attended by about 1,000 students, and the shorter courses in agriculture, there are this year 4,900 students in the university, giving it a rank in size just above the University of Wisconsin and the University of Minnesota. There are 481 professors and other officers who accomplish, apart from the teaching of the students, a large amount of research work and public service of benefit to the state and to the country.

SCIENTIFIC ITEMS

WE record with regret the death of Dr. Eugene Woldemar Hilgard, professor emeritus of agriculture in the University of California; of Dr. Arthur Williams Wright, professor emeritus of experimental physics at Yale University; of Daniel Giraud Elliot, known for his contributions to mammalogy and ornithology, and of Sir Henry Enfield Roscoe, the distinguished chemist, emeritus professor in the University of Manchester.

AT the Columbus meeting of the American Association vice-presidents were elected as follows: Mathematics, L. P. Eisenhart, Princeton University; physics, H. A. Bumstead, Yale University; engineering, E. L. Corthell, Brown University; geology and geography, R. D. Salisbury, University of Chicago; zoology, G. H. Parker, Harvard University; botany, T. J. Burrill, University of Illinois; anthropology and psychology, F. W. Hodge, Bureau of Ethnology; social and economic science, Louis I. Dublin, New York; education, L. P. Ayres, the Russell Sage Foundation; agriculture, W. H. Jordan, the New York State Experiment Station.

THE SCIENTIFIC MONTHLY

MARCH, 1916

PLANT DISTRIBUTION IN CALIFORNIA

By Professor DOUGLAS HOUGHTON CAMPBELL

STANFORD UNIVERSITY

CALIFORNIA is easily first among the states of the Union in the variety and interest of its flora. Indeed there are few regions in the world which surpass it in these respects, and the problems dealing with the origin and distribution of this rich flora are full of interest.

In a paper such as the present one, it is clear that only the more obvious factors controlling plant distribution can be considered. There are many important but often very obscure problems which must be passed over here. Indeed the writer feels himself quite incompetent to deal at all with many of these.

Probably the most important factor determining the character of its flora is the geographical position of California. Covering almost ten degrees of latitude, 32° 40′ to 42°, it lies well within the warm temperate zone with conditions of temperature conducive to a luxuriant vegetation. The state is peculiarly isolated, as the high mountains and deserts to the east offer an impassable barrier to plants from the Atlantic side of the continent, while to the south are the deserts of Mexico and lower California, and on the west lie the shores of the Pacific. The state thus has many of the characteristics of an oceanic island. This isolation, no doubt, accounts for the extraordinary proportion of endemic plants found in California.

Aside from latitude the great factors controlling the climate of California are four in number, viz., (1) the great oceanic and continental barometric areas; (2) the prevailing west-to-east drift of the atmosphere characteristic of temperate latitudes; (3) the proximity of the Pacific ocean; and (4) the extraordinarily varied topography of the state.[1]

The Pacific ocean, whose immense volume of water varies but little in temperature during the year, acts as a huge thermostat and gives the whole Pacific coast an extraordinarily equable climate. Along the middle California coast the water is cold, having an average tem-

[1] For details, see the very interesting account of the climate of California, "The Climatology of California," Alexander G. McAdie, Washington, Government Printing Office, 1903.

perature of 55°, so that the summer climate of the immediate coast is relatively very low. The coast region of California feels the full benefit of the proximity of the ocean during the summer, as the prevailing winds are from the ocean, and only occasionally do land winds occur. The hottest month in San Francisco has a mean temperature of only about 60 degrees, although it lies in about the same latitude as Washington, where the mean of the hottest month is nearly 20 degrees higher. On the other hand, the coldest month of the year in San Francisco is only 10 degrees less than the hottest, while in Washington the difference is more than four times as great. In very exposed places the difference may be even less marked, and practically the same temperature prevails throughout the year. The equalizing effects of the ocean are also shown in the slight differences in temperature due to the latitude. Thus between Eureka, on the northwest coast, and San Diego, at the extreme southern end of the state, equivalent to the difference between New York and Savannah, the mean annual temperature difference is only about ten degrees.

Temperature variations in California are far more a question of topography than of latitude. During the summer it is not unusual to find a difference of 30 to 40 degrees in the maximum temperatures on the same day between a coast station and a station 100 miles inland. Thus when at San Francisco the maximum temperature may be under 60 degrees it might reach 100 degrees in Sacramento or Fresno; while at San Diego, 500 miles south, it would probably be not more than 10 degrees warmer than in San Francisco. Much greater differences might be noted for some of the stations in the southeastern desert, where temperatures of 130 degrees have been recorded, with a monthly average temperature of 100 degrees. The lowest temperature in the state is in the High Sierra, where temperatures of about minus 30 degrees have been recorded.

Even a few miles are sufficient to make a great difference. Thus at Stanford University, about 30 miles south of San Francisco, the mid-day temperatures during the summer are usually from 10 degrees to 20 degrees higher than in San Francisco. This is due solely to the fact that the former is protected from the sea by a range of mountains shutting off the fog and much of the ocean wind to which San Francisco is fully exposed.

To a visitor from the eastern states the climatic conditions so totally different from those to which he is accustomed, are rather perplexing. Throughout the Pacific coast the year is divided practically into two seasons, the wet or winter season and the dry summer. To quote Bret Harte:

> Warm and wet, and drear and dry,
> Half a year of clouds and flowers,
> Half a year of dust and sky.

These differences are much more pronounced in California than in the regions further north, and the annual precipitation falls off very rapidly as we proceed southward. Eureka, on the northwest coast of California, has more than four times as much rainfall as San Diego, on the extreme southern coast (the annual means: Eureka 46.04 inches, San Diego 9.52 inches).

In a sense the seasons are reversed when compared with those of the Atlantic states, as the summer, except in the northern areas and in the mountains, is almost completely a dormant period for vegetation. Of course, in the regions of heavy snowfall and severe cold, vegetation comes to a standstill in the winter, but in the lower elevations there is never a complete cessation of plant growth. Even in regions where there is an abundant summer vegetation, as in the Sierras, this mainly depends for its maintenance upon water in the soil derived from melting snow, as summer rains are of rare occurrence anywhere in the state. This long dry period, lasting sometimes in Central California for upwards of six months, no doubt accounts for the predominance of xerophytic plants in California. A large proportion of the trees and shrubs are evergreen, and conifers are the dominant forest trees. Among the herbaceous plants there is an extensive development of annuals, which germinate with the first rains and complete their growth before the dry months. Another type of herbaceous plants is seen in the very numerous bulbous and tuberous species, especially members of the lily family. The awakening of vegetation begins not in the spring, but in the fall with the advent of the first winter rains. With the cessation of rain in April or May vegetation goes to rest for the summer.

The conditions governing the rainfall in California are similar to those controlling the temperature, and are largely topographical. As in the temperatures there is an extraordinary difference in the rainfall at different points in the state. Some northern stations may have more than 100 inches in a year, while in the desert in the southeast, a year may pass with practically no rain at all. The highest mean annual precipitation given by McAdie is 81 inches at Upper Mattole, in Humboldt County, on the northwest coast, but in some years the rainfall exceeds 100 inches, and he notes one annual rainfall of 120 inches, at Laporte in 1896. At one station in the southern desert, Mammouth Tank, the mean annual rainfall is only 1.81 inches, while in some years practically no rain at all has fallen.

While in general, as we have seen, the rainfall diminishes southward, there may be a great variation between stations only a short distance apart, due to the topography. Thus at Boulder Creek in the Santa Cruz Mountains, about 25 miles distant from Palo Alto, there is over three times as much rain as falls at the latter place.

These differences in humidity are plainly reflected in the vegetation

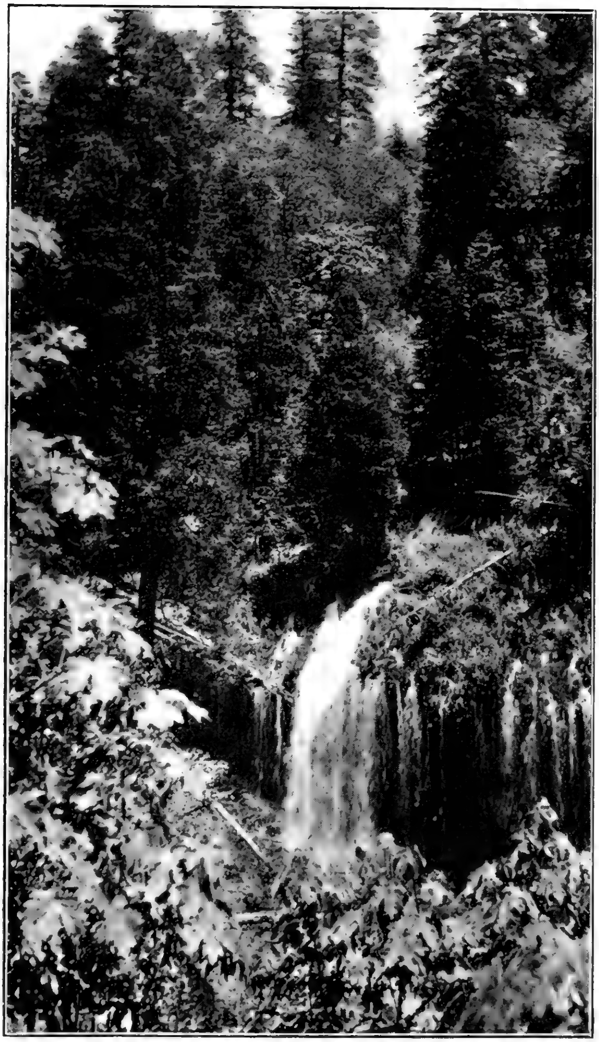


FIG. 1. DENSE FOREST IN THE UPPER CANYON OF THE SACRAMENTO, NEAR MT. SHASTA.

in different parts of the state. In the cool humid coast region of the north are found the tallest trees in the world, the redwoods, while the density of these redwood forests is hardly equalled anywhere in the world. On the other hand, certain regions of the intensely hot and arid deserts of the southeast corner of the state can support no vegetation at all, and others not quite so arid have only the scantiest flora, composed of such extreme xerophytes as the cacti, creosote bush and palo verde.

The peculiar topography of California is therefore largely responsible for the distribution of its flora. In the middle region are the three parallel ranges of mountains, the outer and inner coast ranges and the

great range of the Sierra Nevada. At the north these ranges come together in a transverse range, the Siskiyous, between California and Oregon; and towards the south is a similar transverse range, the Tehachapi. Between these mountain ranges are numerous valleys, of which by far the most important is the great Central Valley, drained by the Sacramento and San Joaquin Rivers, and extending for half the entire length of the state.

The outer coast range receives the full benefit of the moisture-laden winds from the ocean, while the valleys lying inside of the range are very much drier, and this is still more marked in the great Central Valley and in the regions south of the Tehachapi, most of which are really deserts.

The outer ranges are only of moderate elevation, but in the Sierras are the highest peaks in the United States proper, while in Death Valley and the Colorado Desert are areas lying 300 feet below sea level. This gives a range of elevation in California of nearly 15,000 feet.

Combined with these extraordinary differences in elevation is an equally marked variation of soil conditions, suitable practically for every sort of plant.

Corresponding to the extraordinarily diversified conditions prevailing in California, it is not to be wondered at that the flora of the state presents a variety quite astounding to the botanist accustomed to the comparatively uniform vegetation of the Atlantic half of the country. Whereas in the regions east of the Rockies there are no important barriers to the free migrations of plants, aside from questions of temperature and moisture, in California there are many barriers against such migration, and one finds within the limits of the state distinct floras

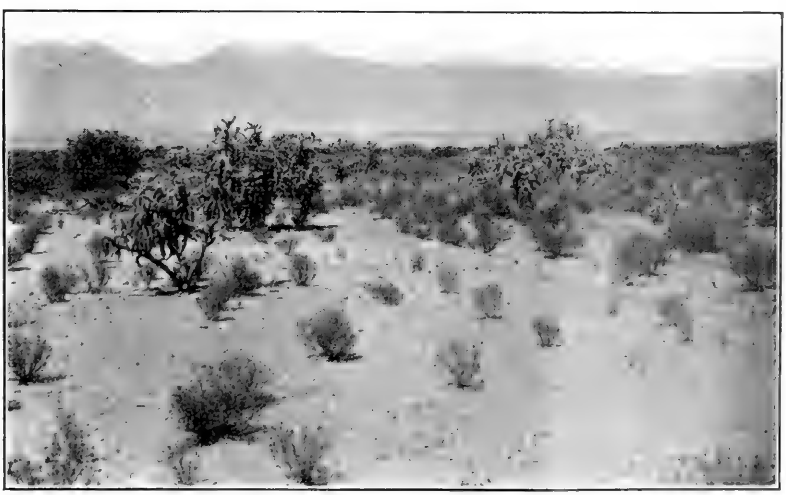


FIG. 2. DESERT NEAR TUCSON, ARIZONA. (Photo. Dr. W. S. Cooper.)

FIG. 3. REDWOOD FOREST NEAR STANFORD UNIVERSITY. (Photo. Robinson & Crandall, Palo Alto.)

which differ much more widely from each other than any that could be found in the Atlantic half of the country. In the well-watered areas of Atlantic America, lying east of the great plains, there are many species that range practically over the whole area. Such trees as the white elm, oaks of several species, maples and hickories extend over pretty much of this whole area, and the same is true of many other plants, so that the flora is very similar throughout the range, the main differences being the addition of new species to the northern flora in the moister and warmer regions of the southern states, and the disappearance of certain boreal types.

In California, however, the difference between certain floras is absolute. Thus the contrast between the dense redwood forests of the north, where the vegetation is fairly tropical in its luxuriance, and the flora of the Colorado and Mojave Deserts, parts of which are absolutely destitute of vegetation, is about as complete as it could well be; and except for a few species of aquatics, such as the cat-tails of the marshes and ditches, it is doubtful if the two regions have a single species in common. Even within quite short distances one finds a remarkable difference in the type of vegetation, due to rapid changes in elevation, as in ascending the slopes of the Sierra Nevada, or to differences in soil and moisture, as in the transition from the redwood forests of the outer coast ranges to the flora of the open valleys lying east of the mountains.

In the mountains to the west of Stanford University, a distance of less than 10 miles, there is a very heavy growth of redwood, with the accompanying mesophytic flora, largely made up of northern types, *e. g.,* brambles, ferns of several species, lilies, violets, wood-sorrel, clintonia, lady slippers, trillium and other types quite familiar to the eastern botanist. These northern plants sometimes follow the beds of streams flowing into the valley, but the floor of the valley is for its most part only sparsely wooded, mainly with oaks—quite different from the eastern species, especially the characteristic live oak (*Quercus agrifolia*), which is so prominent a feature in the valley landscape of the coast region of California.

In places the open ground is covered with a growth of chaparral (dense scrub) made up of a variety of species. Among these are the poison-oak (*Rhus diversiloba*), the California buckeye, a woody composite (*Baccharis*), the toyon (*Heteromeles*), and other unfamiliar-looking shrubs. The open ground not occupied by the chaparral supports a growth of annual grasses, among which in the spring are masses of wild flowers, mostly annuals, but comprising a number of perennial species, especially bulbous Liliaceæ. These are mostly genera poorly represented in the eastern states (*e. g., Lupinus, Trifolium*) or else entirely different genera, *e. g., Gilia, Godetia, Orthocarpus,* and many others. These latter are most of Mexican affinities, but a good many

genera are peculiar to California. Later in the season and persisting until the autumn, are a small number of flowering annuals, mostly Compositæ. Among these perhaps the most characteristic are the tarweeds of the genus *Hemizonia*.

As an example of change due to elevation, with, of course, accompanying increase in precipitation, the ascent of the Sierra Nevada from the great central valley is very instructive. This great valley has a scanty rainfall which is often insufficient for any tree growth away from the streams, and the level floor of the valley reminds one of the prairies of the middle west. The foothills develop a scattered growth of oaks, and a little higher up one finds the peculiar digger pine (*Pinus Sabiniana*). Somewhat higher up the yellow pine (*P. ponderosa*) appears, and at elevations of about 4,000 feet, that of the Yosemite, the open forest of the Sierras is well developed; but one must ascend still higher, about 6,000 feet, to see the fullest development of this wonderful forest as one finds it in the belt where the giant Sequoias grow. Here among the huge conifers is a rich growth of deciduous trees, oaks, maples, dogwoods and others, and many beautiful flowering shrubs and herbs. Along the streams and in the low ground are sub-Alpine meadows, in which grow a great variety of beautiful flowers—lilies, asters, orchids, painted-cups, the great hellebore (*Veratrum*), columbine, lupins, gentians, lark-spurs, monk's hoods, and many other showy species.

The forest is well developed up to about 8,000 to 9,000 feet, above

FIG. 4. FOOTHILLS OF SANTA CLARA VALLEY NEAR STANFORD UNIVERSITY. (Photo. Robinson & Crandall, Palo Alto.)

FIG. 5. CONIFEROUS FOREST NEAR MT. SHASTA. Douglas fir predominant.

which only such Alpine trees as *Pinus albicaulis* and *P. flexilis,* and the western juniper occur, hugging the ground and braving the tempests of the exposed summits.

Many species in California are extremely limited in their range, such as the fan palms (*Washingtonia*) found in a few cañons opening into the Colorado Desert; the great bush poppy (*Romneya*) of Southern California; and perhaps best known of all the several local coniferous trees, of which the Monterey cypress and Monterey pine, confined to a few miles of coast near Monterey, are the best known.

ORIGINS OF THE CALIFORNIA FLORAS

The southern part of California is geographically part of the Mexican plateau, and the plants are largely the same as those of the adjacent regions of Mexico, Lower California and Arizona. This is a more or less pronounced desert area, and the characteristic plants are most of them well adapted to resist long periods of drought. Shrubs with small tough leaves or almost leafless, like the "palo verde" (*Parkinsonia*), are characteristic of this region, and in many parts of it the cacti reach a great development. Mesquit (*Prosopis*) and yuccas of various species are also features of this region, as well as a good many annuals, which are particularly abundant in years of good rainfall.

FIG. 6. DESERT NEAR TUCSON, WITH GIANT CACTUS, *Cereus giganteus*. (Photo. Dr. W. S. Cooper.)

In the mountains, with the increasing moisture in the higher elevations, a forest develops but much less luxuriant than that of the northern part of the state. One of the most striking types found in the southeast part of California is the palm, *Washingtonia,* already referred to. This is the only palm growing native within the limits of the state.

Many of these Mexican types, of both woody and herbaceous plants, extend northward through the drier valleys and along the mountain slopes to the extreme north part of the state.

Going northward, however, especially in the cool, moist regions of the coast ranges and the high Sierras, plants of a very different character begin to be abundant, and it is evident that these are plants of northern origin, and one encounters many genera familiar to the eastern botanist. Roses and brambles; huckleberries, rhododendron and azaleas; maples

and dogwoods; lilies, violets, trilliums, buttercups and other northern genera are common. Owing to the coolness and moisture of these outer coast ranges, many of these northern types, following the mountains south, reach well beyond middle California.

In this region there is a mingling of the northern and southern floras, which is particularly well illustrated in the regions about San Francisco Bay, where the northern types as a rule occur in the redwood belt, and in the shady cañons where there is an abundance of moisture, and lower temperatures than prevail in the open valleys and on the exposed slopes of the mountains. In the latter areas there is a predominance of southern species.

A characteristic form of this southern xerophytic vegetation is seen in the "chaparral," the dense scrub which covers the exposed hillsides and, also, to some extent, the floor of the valleys. This is well developed in the neighborhood of Stanford University, where the chaparral includes dwarf oaks, wild lilac (*Ceanothus*), manzanita (*Arctostaphylos*), species of wild currant, roses, a large shrubby composite (*Baccharis*), "yerba santa" (*Eryodictyon*), buckeye, poison oak (*Rhus diversiloba*), *Garrya, Adenostoma,* and others. This "chaparral" very much resembles the similar formation "macchie," "maquis" of the shores of the Mediterranean.

The redwood formation, which is largely controlled by the amount of precipitation—including the copious summer fogs—comprises a number of characterisic species mostly of northern affinities. Thus with alders, maples, willows and dogwoods along the streams, there are evergreen oaks of a very different type from the eastern species, and other evergreen trees and shrubs, the most notable of which are the madroño (*Arbutus menziesii*) and the California bay tree (*Umbellularia*), forms which are quite unrepresented in eastern America. The most characteristic trees of the open valley are scattered oaks, of which two species predominate, the live oak (*Quercus agrifolia*) and the valley white oak (*Q. lobata*). These usually grow scattered about the valley and foothills, but sometimes on northern exposures they form associations that are sufficiently dense to be called forests. The open ground is largely occupied by a growth of annual grasses, among which grow a great variety of beautiful flowers like *Nemophila, Platystemon,* the California poppy, lupins and other annuals, but also including a number of perennial forms, especially the bulbous Liliaceæ such as *Brodiæa* and the beautiful mariposa lily (*Calochortus*). Growing with these native plants, especially where the ground has been cultivated, there are certain introduced weeds which occur in great numbers and contest the ground with the native plants. Among these introduced weeds may be mentioned the wild mustard, the "filaree" (*Erodium*) and the wild oats.

Along the shores of the bay are extensive salt marshes with a characteristic and interesting flora.

FIG. 7. *Azalea occidentalis.* A characteristic shrub of the moister forests.

A notable element in the Californian flora is one apparently of old world origin. In the northern coast region occur species like the Sitka spruce and western skunk cabbage (*Lysichiton*), which are also found in Kamtchatka; another old world genus is *Fritillaria,* of which species occur all the way from Alaska to San Diego, and one extends eastward as far as the Yellowstone Park. Of broad-leaved trees, the tan-bark oak

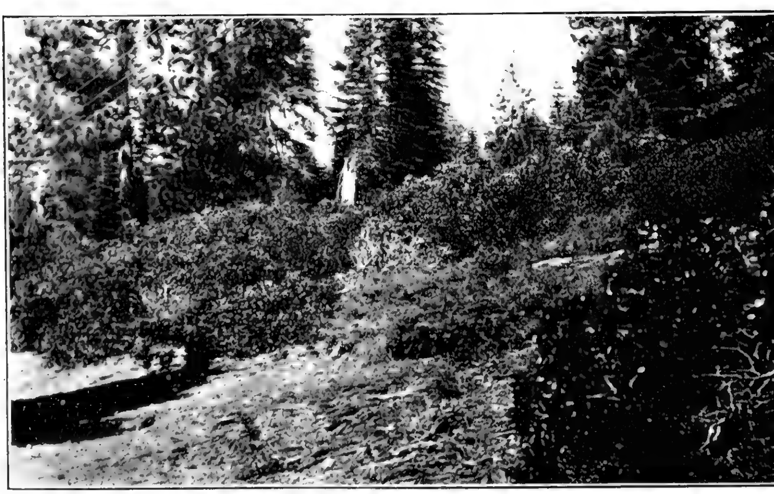


FIG. 8. CHAPARRAL FORMATION, LAKE TAHOE. The predominant shrubs, manzanita and species of *Ceanothus.*

(*Pasania densiflora*) is the only American representative of a genus largely developed in tropical and subtropical Asia, and the madroño (*Arbutus*) is also an old world genus which is not found in Atlantic America. Of herbaceous plants an interesting example is seen in the genus *Trientalis*, of which there is in eastern America a well-marked species, but the Pacific coast form is a variety of the old world *T. Europæa*. Whether these Eurasian types are comparatively recent immigrants, or whether they are relics of the old tertiary floras which have persisted on the Pacific coast, is not quite clear.

There are also examples among the lower plants, which apparently have had a similar origin. Among these may be cited the giant horsetail (*Equisetum maximum*), the fine fern *Woodwadia radicans* and a liverwort, *Targonia hypophylla*.

Fig. 9. *Ceanothus* sp. A characteristic chaparral shrub.

The seashore of California has a varied and extremely interesting flora. There are extensive sand dunes and beaches, as well as bluffs and rocky headlands. Among the striking plants of the dunes may be mentioned the tree lupins, species of *Mesembryanthemum*, the sand Verbena (*Abronia*), many showy Compositæ and others. Probably to the botanist the most striking features of this coast region are isolated groves or "islands" of conifers, of which there are several species of extremely limited range. The Monterey pine (*Pinus radiata*) and the Monterey cypress (*Cupressus macrocarpa*) are the best known.

Inside the shore zone lies, in middle and northern California, the outer coast range which sometimes comes close to the sea. Where the exposures to the strong ocean winds are not too great there is developed

in these coast mountains one of the most remarkable forests in America, and probably in the size and density of the tree growth one that is unequaled in the world. The predominant tree of this region is the coast redwood (*Sequoia sempervirens*), even surpassing in height its great cousin of the Sierra forests. In its northern ranges there are pure stands of these giant trees of extraordinary density, but southward the forests are usually more open and there is an intermixture of species, including the Douglas fir, *Torreya*, tan-bark oak, madroño and some other species. The limits of the redwood belt are practically determined by the sea fogs which prevail along the coast during the summer season. This fog takes the place of summer rains, and the vegetation of the redwood belt is largely mesophytic in character, with a predominance of northern genera. On the inner slopes of the ranges the moisture is usually insufficient to support a heavy growth of redwoods, and where they disappear they are replaced by shrubs and trees of a more xerophytic type, and these also largely disappear on the dry floor of the valleys.

In Central California there is a second range, the inner coast range, parallel to the outer one, and between these are numerous sheltered valleys, often of great fertility; while between the inner coast range and the Sierras lies the great central valley drained by the Sacramento and San Joaquin Rivers, which break through the inner coast range and discharge their waters together into San Francisco Bay.

These valleys have only a moderate rainfall, especially the great central valley, and those further south, and there is only occasionally developed in these associations of trees that can properly be called a forest. The floor of the valley and the lower foothills are usually covered with a growth of annual grasses, and where the uncultivated areas have been left we find in spring a profusion of the showy annuals and bulbous plants already referred to.

To the botanical student, probably the most interesting elements of the Californian flora are the conifers, which in size and variety surpass those of any other region in the world. These conifers reach their greatest development on the west slopes of the Sierras of Middle California at an elevation of some 4,000 to 6,000 feet. In this belt grow the giant Sequoias, accompanied by several other species, of which the most prominent are the yellow pine (*P. ponderosa*), the sugar pine (*P. lambertiana*), the white fir (*Abies concolor*), the incense cedar (*Libocedrus decurrens*), and the Douglas fir (*Pseudotsuga taxifolia*), all trees of gigantic size. At higher elevations other species supplant these to some extent, and altogether there are about 60 species of coniferous trees in the state, a larger number than occurs over all the rest of the United States.

True Alpine floras occur in the higher elevations, above 9,000 feet, but are less developed than in the moister regions further northward, as

in the Cascade ranges of Washington and the Canadian Rockies; but there are, nevertheless, many very beautiful true Alpine forms, such as the species of *Bryanthus,* gentians, phlox, primroses and various others.

The sub-Alpine flora is well developed wherever there is sufficient moisture, and the wet meadows full of brilliant flowers are very beautiful.

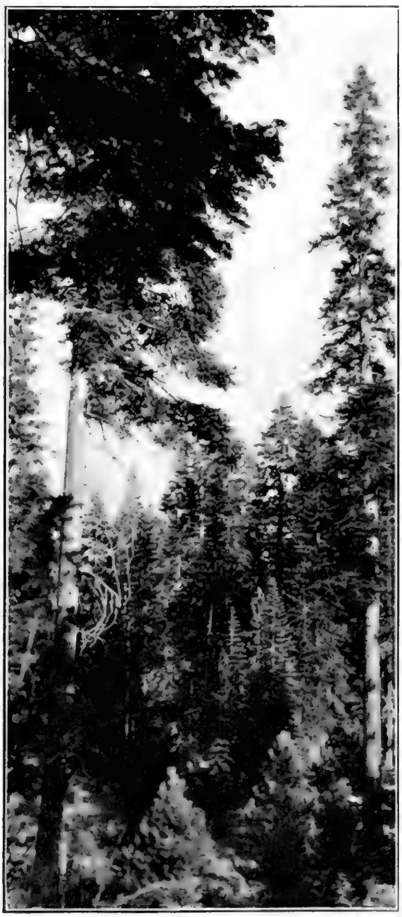


FIG. 10. CONIFEROUS FOREST, LAKE TAHOE. The tall tree is white fir (*Abies concolor*), the predominant species in this region. Note the man standing near the base of the tree.

FIG. 11. SUGAR PINE (LEFT), RED FIR (*Abies magnifica*) (RIGHT). Near Lake Tahoe, about 6,500 ft. elevation.

While most of California north of the Tehachapi range has an adequate rainfall, the southern part of the state, except near the coast, is largely a desert, and in some parts deserts of the most pronounced character, as in Death Valley and parts of the Colorado Desert.

The flora of this region, as we have already indicated, is mainly Mexican and has very little in common with much of the northern part of the state.

FIG. 12. YELLOW PINE (*Pinus ponderosa*). Near Mt. Shasta, elevation about 3,000 ft.

A marked feature of most of Californian plants is their "xerophytic" character, *i. e.*, their adaptation to long periods of drought. This is conspicuous in the trees, which are largely conifers or else broad-leaved evergreens, like the live oak, madroño and laurel. It is also marked in very many of the shrubs, which have small evergreen leaves. The shrubby plants making up the "chaparral" are largely evergreen, *e. g.*, wild lilac, the manzanita, chinquapins, dwarf oaks and others.

Owing to the isolated position and numerous barriers within the state, California presents an extraordinarily large number of "endemic" or peculiar species, some of which are of very limited range, such as the peculiar conifers of the coast region. I have not been able to find any tabulation of the proportion of the endemic species, but it

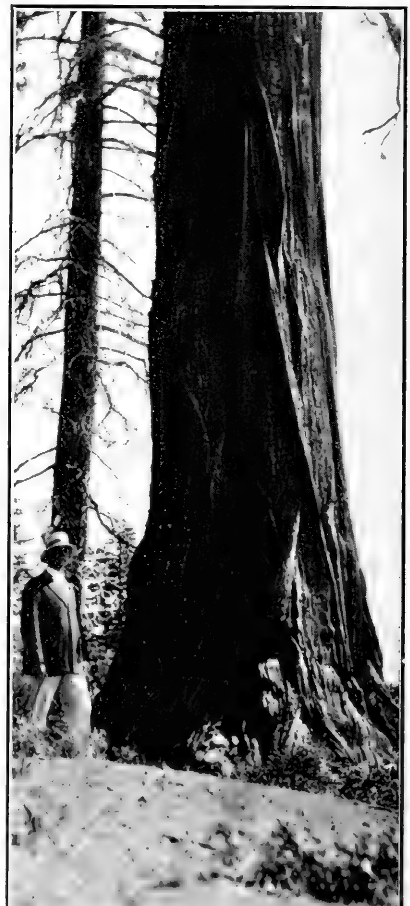


FIG. 13. INCENSE CEDAR (*Libocedrus decurrens*), LAKE TAHOE.

certainly must be very much greater than that of any other part of the United States. The marked development of endemism is seen in very many large genera, such as *Calochortus, Lupinus, Trifolium, Gilia* and various others. The majority of these species is exclusively Californian. Thus in the genus *Lupinus* about half of the known species are found in California, and a large majority of these is peculiar to the state.

Many species are extremely variable and the limits of species difficult to determine. California should be an exceptionally favorable region for studying variations under natural conditions. Perhaps some light might thus be thrown upon the vexed question of "mutations," and other factors concerned in the origin of species.

INDUSTRIAL RESEARCH IN AMERICA[1]

By RAYMOND F. BACON

DIRECTOR OF THE MELLON INSTITUTE OF INDUSTRIAL RESEARCH OF THE UNIVERSITY OF PITTSBURGH

EVEN before the United States became a republic, some interest in industrial research was manifested.[2] This is evidenced in the preface to the initial volume of the *Transactions of the American Philosophical Society,* published in 1789, in which the aims of the society were presented. Among these were "making useful discoveries that would . . . promote the interest of the country." The earliest contribution to chemistry from this country, bearing the date September 10, 1768, appears in the *Transactions* of this society under the title "An Analysis of the Chalybeate Waters of Bristol in Pennsylvania," by John de Normandie.

The principal object of the Chemical Society of Philadelphia, which was founded in 1792 and was thus the first chemical society in the world, was to secure information relating to the minerals of the United States. A standing committee of five chemists was charged with the duty of analyzing any mineral which might be submitted to it, provided it was forwarded free of expense, with an account of the locality and situation in which it was found. The analyses were made without charge. In 1799, this society also gathered information relating to the manufacture of niter, acquainted the public with the uses of various minerals, and encouraged the manufacture of pottery. Evidence of the interest which was evinced at this time in ceramics may be found in an oration delivered by Felix Pascalis before the Chemical Society of Philadelphia in 1801. This savant said:

> Encourage and repeat mineralogical experiments on all kinds of alumine. The first who will successfully procure manufactured works of the kind and tolerably good earthen wares will deserve well of his country and be rewarded by the gifts of fortune.

Early Industrial Researchers

Among the earliest American scientists who became interested in the chemistry of manufacturing processes was James Woodhouse, professor

[1] Excerpts from a public address delivered at the Columbus, Ohio, meeting of the American Association for the Advancement of Science, December 29, 1915.

[2] It may be noted here that the first manufactures in colonial America—glass in 1610 and leather in 1630, both of which were established in Virginia—were chemical in nature.

of chemistry in the medical department of the University of Pennsylvania from 1795 to 1809. Woodhouse was the first to demonstrate the superiority of anthracite over bituminous coal "for intensity and regularity of heating power." Contemporaneous with this chemist were the following: Robert Hare, the inventor of the oxyhydrogen blowpipe (1802), who obtained calcium carbide, phosphorus, graphite and calcium by the aid of electricity, and is to be regarded as the earliest American experimenter in electrochemistry; Joseph Cloud, assay master at the Philadelphia Mint, who, in 1807, made an interesting research—the first in metallurgy in this country—on a native alloy of palladium and gold from Brazil; John Harrison, the first manufacturer of sulphuric acid in this country (1793), who was an ingenious industrialist and made a number of technical innovations in practise; and Gerard Troost, professor of chemistry at the University of Nashville, who established works for the production of alum at Cape Sable, Maryland, in 1814.

Considerable industrial research was carried on in the United States from 1820 to 1860. James Cutbush, professor of chemistry at West Point, made a number of valuable contributions to scientific pyrotechnics, but is chiefly remembered for his description, published in 1822, of the production of cyanogen by the action of nitric acid upon charcoal. Our first prominent industrial chemist, Samuel Guthrie, of Sackett's Harbor, N. Y., discovered chloroform, engaged in the manufacture of fulminating compounds, and devised a commercial process for the rapid conversion of potato starch into sugar (1832). Our first real metallurgical chemist, W. W. Mather, of Columbus, Ohio, made an elaborate research on the principles involved in the reduction of Mexican silver ores, in 1833. Lewis Feuchtwanger, who was well-known to the chemists of this period by his commercial establishment for the manufacture and sale of "rare" chemicals, devised, in 1837, an expeditious method for the manufacture of vinegar and later, in 1872, studied the process of glass-making. Then there was S. L. Dana, of Lowell, Mass., who was, for fifty years, the acknowledged authority in the United States on technical chemistry. After the completion of his medical studies in 1818, Dana soon devoted himself to manufacturing chemistry, holding the position of chemist to the Merrimac Print Works from 1833 to 1868; he invented the "American system" of bleaching in 1838, and was also an authority on manures and lead poisoning.

Among the other chemists of this period who busied themselves in the domain of industry were: J. C. Booth, of Philadelphia, Pa., noted for his work on beet sugar (1842), the production of gelatin (1842), the nickel ores of Pennsylvania (1856), and illuminating oils (1862), as well as for being the founder of an active firm of chemical consultants; John Dean of Boston, Mass., who investigated the value of different

kinds of vegetable foods in 1844; David Alter, of Freeport, Pa., the discoverer of spectroscopy, who began the manufacture of bromine in 1846 and later became a coal-oil technologist; Charles Lennig, an industrialist of Philadelphia, who was the first to manufacture bleaching powder in the United States (1847) and afterwards (1869) introduced the manufacture of hydrochloric acid by modern methods; L. C. Beck, professor of chemistry in Rutgers College, who made valuable observations respecting bleaching and disinfecting compounds and was an authority on bread-stuffs (1848); A. C. Twining, a chemical engineer of the fifties, who invented an ice machine; A. A. Hayes, of Brookline, Mass., a productive student of the Bessemer process (1852); C. M. Wetherill, who conducted researches on illuminating gas in 1854 and on the manufacture of vinegar in 1860; Benjamin Silliman, Jr., the author of technochemical classics on Pennsylvania petroleum (1855), California petroleum (1865 and 1867), and on the combustion of fuel (1860); E. N. Horsford, a researcher of great ability who worked out processes for preparing phosphoric acid (1856) and was active in establishing markets for this product; Henry Wurtz, of New York, who played an important part in the development of the manufacture of glycerol in 1858; and J. M. Ordway, of the Massachusetts Institute of Technology, who investigated the manufacture of sodium hydroxide in 1858 and the manufacture of water-glass from 1861 to 1865.

Industrial Research from 1860 to 1880

The late Joseph Wharton, of Philadelphia, deserves especial mention in the history of technology in America. After some preliminary experiments, Wharton erected at Bethlehem, Pa., in the year 1860, a spelter works of 16 Belgian furnaces, which produced over 3,700,000 pounds of zinc in 1862. The product was of excellent quality, and was made so cheaply as to afford a reliable profit and to plant the zinc industry firmly in the United States. Wharton first reduced silicate of zinc to metal on a large scale, successfully applied anthracite to the manufacture of spelter, and used American clays for making zinc retorts.

Many chemists rendered service to the advancement of industry during these two decades, and it is indeed difficult to designate the most prominent researchers. B. F. Craig, of the laboratory of the Army Medical Museum at Washington, D. C., worked in the field of explosives and, during the period 1861–1864, made a number of contributions to our knowledge of gunpowder. Frederick Hoffmann, of New York, was an authority on organic colors and medicinal chemicals. C. A. Goessmann, of the Massachusetts Agricultural College, contributed to the manufacture of salt (1863), the refining of sugar (1864), and the pro-

duction of beet sugar (1872). F. H. Storer, of Harvard University, made researches on the alloys of copper and zinc in 1864 and on petroleum in 1865.

While charged with responsible duties of administration, Charles F. Chandler, at present the honored dean of American chemists, was always productive in research. His early researches of technical importance were those on water for locomotives (1865), the water supply of New York (1868 and 1870), the purification of illuminating gas (1870), kerosene (1871), and the manufacture of condensed milk (1871). Another chemist who was called upon by the gas industry was Henry Wurtz, who made improvements in the methods of purifying water-gas (1867) and, jointly with Silliman (1869), elucidated the processes of manufacture.

The noteworthy researches of S. F. Peckham on asphalt and petroleum were carried on from 1867 to 1874. W. H. Chandler, who, with C. F. Chandler, edited the *American Chemist,* contributed to the purification of zinc containing iron (1869) and to the refining of iron (1870). J. B. Britton, chemist to the "Iron Masters' Laboratory," performed a great amount of technical work in ferrous metallurgy. S. Dana Hayes, state assayer of Massachusetts, studied the destructive distillation of naphtha in 1871 and was recognized as an expert in petroleum technology. Isidor Walz, of New York, was a textile expert. C. U. Shepard, Jr., of Charleston, N. C., an authority on fertilizers, investigated the effects of sulphur dioxide on vegetation in 1872. Henry Morton, of Stevens Institute, had occasion to conduct an extensive series of researches on petroleum from 1872 to 1874. J. P. Kimball, of Lehigh University, engaged in work in the manufacture of iron and steel, and found uses for emery in the iron industry (1873). The Nestor of the mining engineering profession, R. W. Raymond, investigated the calorific value of lignites in 1873. J. F. Babcock, of Boston, Mass., carried out researches which established him as an expert on wood preservation. T. M. Drown, professor of chemistry at Lafayette College, was the author of important papers on the blast furnace, the puddling and Bessemer processes, and the conditions of carbon in gray and white pig iron. H. M. Pierce was most active in the promotion of the interests of the wood distillation industry. C. E. Avery, of Boston, Mass., laid the foundation for the manufacture of lactic acid. Charles and Nelson Goodyear and A. G. Day, known for their inventions in connection with india rubber, may also be included among the industrial researchers of this period.

Industrial Research During the Last Three Decades

Sufficient has been presented to show that American scientists have, from the inception of the republic, been constantly engaged to a greater

or less degree in original investigations of the problems of manufacturing. Time will not permit the recounting of the many valuable contributions which have been made by the chemical profession during the most modern period of our industrial history, from 1880 to the present time. With your permission, I shall, however, refer to some of the most noteworthy researches.

The first electrochemical enterprise to be established at Niagara Falls was that of the present Aluminum Company of America for the manufacture of aluminum according to the process of Charles M. Hall. It was indeed remarkable that, after all the attention which had been given to aluminum, it remained for this young Oberlin graduate to devise the process by which 50,000 metric tons are now being produced annually in the United States and Canada. Hall possessed all the characteristics of an inventive genius.

Another distinguished electrochemist, H. Y. Castner, invented processes for the production of sodium and sodium hydroxide; while E. G. Acheson has discovered carborundum, artificial graphite, deflocculated graphite, and siloxicon. Both of these pioneers in modern electrochemical research succeeded in founding great manufacturing establishments, monuments to their rare investigative ability. Other chemists who have engaged with success in this field are the following: C. E. Acker, who devised a process for the manufacture of sodium hydroxide and bleaching powder which differs from the Castner process; W. T. Gibbs and S. P. Franchot, who invented a commercial process for the electrolytic production of potassium chlorate; T. L. Willson, who was the pioneer in the manufacture of calcium carbide and acetylene; Isaac Adams, the inventor of nickel-plating; and E. R. Taylor, who worked out a resourceful method for the commercial production of carbon disulphide.

Other brilliant inventors in the domain of chemical industry have been Herman Frasch, whose most valuable processes relate to the refining of petroleum and to the extraction of Louisiana sulphur; Waldron Shapleigh, who worked up methods for the extraction of the rare-earths from monazite; Thomas A. Edison, who, among many other things, first evolved a successful system of incandescent electric lighting; Charles Steffen, the deviser of the process for working over the mother liquors in beet-sugar manufacture; the Hyatts, who founded the great nitrocellulose industry; Arno Behr, who had such an active part in the development of the great corn-products industry; and J. B. F. Herreshoff, the eminent copper metallurgist and chemical engineer. These are a few of the researchers who have played a prominent part in the establishment of our industrial prosperity.

The Present Industrial Activity of the Chemist

If it is conceded that chemistry is the intelligence department of industry,[3] one may therefore conclude that the measure of the influence of the profession of the chemist upon the industrial development of our country constitutes *per se* an index of the value of research to manufacturing. I have pointed out in another place[4] that the measure of a country's appreciation of the value of chemistry in its material development and the extent to which it utilizes this science in its industries, generally measure quite accurately the industrial progress and prosperity of that country.

Early American Chemical Industries

Manufacture	First Manufacturer	Year	First Important Improvement	By Whom	Year
Sulphuric acid....	John Harrison, Philadelphia, Pa.	1793	Platinum still for concentrating.	John Harrison.	1814
Gunpowder......	E. I. du Pont de Nemours, Wilmington, Del.	1802	Manufacture of potassium nitrate from sodium nitrate.	Du Pont Company.	1868
White lead.......	S. Wetherill & Son, Philadelphia, Pa.	1804	The use of cheaper material from Mo. and Ill.	——	1850
Pharmaceutical chemicals......	Rosengarten & Sons, Philadelphia, Pa.	1823	Production of ether and quinine, 1823; morphine, 1832; strychnine, 1834.	Rosengarten & Sons.	—
Varnish..........	P. B. Smith, New York, N. Y.	1828	Improvement of quality to create a foreign market.	P. B. Smith.	1836
Wood distillation .	James Ward, North Adams, Mass.	1830	Manufacture of acetate of lime and wood alcohol.	J. A. Emmons and A. S. Saxon.	1867
Nitric acid.......	Carter and Scattergood, Phila., Pa.	1834	Distillation apparatus.	Edward Hart.	1898
Hydrochloric acid.	Carter and Scattergood, Phila., Pa.	1834	Manufacture by modern methods.	Charles Lennig.	1869
Chlorine.........	Charles Lennig, Bridesburg, Pa. (bleaching powder).	1847	Commercial process for the electrolytic decomposition of sodium chloride.	E. A. LeSueur.	1893

3 This statement should not give rise to an impression that the contention is that the industrialist relies *absolutely* upon the chemist. The technical demands made by modern manufacturers are extensive and exacting, and sole reliance upon the chemist would be oftentimes fatal to the realization of success. The aid of other industrial specialists must always be called in during the course of development.

4 *Science*, 40 (1914), 871–81.

The public has been left to its own resources to determine the function of that industrial scout, the chemist. This condition has been briefly explained by one chemist:

> Our public work is obscured by impenetrable technical detail and our industrial achievements are cut off from public view by high factory walls.

A large percentage of the 10,000 chemists of the United States do labor under cover, yet these 10,000 men—about 25 per cent. of whom are engaged in industrial research, the others in control work—are actively occupied in manufactures which affect over 1,000,000 wage earners and produce over $5,000,000,000 worth of products. As Hesse[5] has quite convincingly demonstrated, in the case of thirty-one American industries, the chemists employed therein directly affect 24.6 per cent. of our manufacture values and 20.2 per cent. of our values added by manufacture. They are constantly engaged in the development of processes and in refining methods of control or of manufacture.

The Evaluation of Industrial Research

However, many industrialists are even now certain that research will not pay. Some regard their technology as a hereditary art. Some have favorable raw material conditions or a large demand for their products, and are therefore disinclined to invest a very small portion of their earnings in a reserve of knowledge. Others have prospered because of high tariff, notwithstanding short-sighted management. But most of our industries are built upon stronger foundations. It is plain that the use of natural laws offers a more stable basis upon which to erect a manufacture and a more uniform source of profit than any structure built upon artificial conditions created by legislation. Moreover, the quality and value of a product are based upon the application of correct principles in its conception, preparation and use, and the correct principles can only result from scientific research. Ample support to this contention is to be found in the manufacturing operations of to-day.[6]

The Future of Industrial Research in America

Prophecy is a double-edged tool with a peculiar facility for injuring the user, but the activity of the present leads one to predict that each succeeding year will bring us nearer to the state in which the research work of the country will be national in both scope and effort. The federal government and the states have done and are conducting research of immense value to agriculture, the foundation of industry; but the future will witness a more general application of this principle—an active national interest in industrial research, and this will serve as a healthy

[5] *J. Ind. Eng. Chem.*, 7 (1915), 294.

[6] On the contributions of the chemist to American industry, see Hamor, Sci. Mon., 1 (1915), 86; but especially Bacon, *Sci. Am. Suppl.*, 80 (1915), No. 2081, 334; and *Chem. News*, 112 (1915), 300.

subsidy for American manufactures. Research has enabled our industries to make rapid strides. The recognition of this fact has occasioned a recent awakening to an increased sense of appreciation of the need of greater facilities for insuring the scientific development and extension of industry and commerce and of promoting industrial research. Let us therefore proceed towards the adoption of this plan with unhalting step.

Our universities should make active preparation to assume their share of responsibility in this movement of national preparedness. There is too great a tendency in this country to regard intellectual men as a class apart from business men and especially from industrialists. It is a well-known fact that the German university has been one of the most anarchic of institutions, both the professorate and the students having had greater freedom than in the American universities; and at the present time Germany owes more to its universities as they have been conducted in the past than to its army as it is now organized.[7] In Germany there are captains of the intellectual group as well as of industry and of the military.

We must make ourselves self-sufficient. Some steps have been taken by the government, as, for example, in the formation of the Naval Advisory Board; but this is only a beginning. From the standpoint of real preparedness, the government should know exactly what her scientific and technical experts could best do for American industrial welfare and for their country in the event of war, and full particulars should be available regarding the research laboratories in the United States and the facilities thereof. American scientists are eager to render service to their country and to her industries.

A large industrial firm finds it advantageous to spend about 4 per cent. of its gross annual income on research, in providing for its future welfare and for keeping ahead of its competitors. On the same basis, if the United States expends $400,000,000 annually on its army and navy, it could, with profit, spend $16,000,000 a year on research. An equal sum, spent in the construction of a superdreadnaught, may be either an advantage or a loss; the research of carefully selected scientific men could be only an asset.

All this suggests the formation not only of a great national research laboratory, but also of a central bureau, in, say, the Federal Department of Labor, which would apply trained men to learn what American scientists are doing, their specific fields of investigation, and the equipment and research facilities of their laboratories, as well as to ascertain the problems of the various industries. This bureau could then put industrialists in touch with active university researchers, with the result that there would be an extension of both *useful* scientific investigation and manufacturing efficiency.

[7] See Cattell, *Pop. Sci. Mo.*, 87 (1915), 311.

THE PRESENT STATUS OF THE ANTIQUITY OF MAN IN NORTH AMERICA

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THE passing of that veteran anthropologist, Professor Frederic Ward Putnam, the culmination of Professor Henry Fairfield Osborn's researches in his "Men of the Old Stone Age," and Professor J. C. Merriam's recent exhaustive review in *Science* of the evidences for the early presence of man in California, all combine to make the serious reconsideration of man's antiquity in America a scientific necessity. Without in any way disparaging the valuable contributions of others, the progress so far made may be said to stand as a historical memorial to Professor Putnam, who, in spite of long years of almost barren search, still held firmly on to such faint glimpses of man's antiquity as chance threw in his way. This is not the place to record the history of these researches or to extensively review the formative work of Holmes, Abbott, Volk and others, but some characterization of the problem as it was left by these investigators is possible at this time. The extraordinary triumphs of anthropological research in western Europe naturally lead to measuring American data by these standards. When we take a comparative attitude toward the two, one striking contrast appears, for, while in Europe one finds definitely stratified superimposed beds rich in animal, human and cultural remains, in America we have little more than isolated finds, a stone implement here or a bone there. Some of these finds have called forth a surprisingly large controversial literature and still find places in our standard reference books because no satisfactory conclusion can be reached in the absence of associated faunistic or other chronological indices. Of skeletons, the celebrated Lansing man is typical. The difficulty with it is that no satisfactory faunistic or cultural associates were found and no precise way for dating the river terrace in which the bones were found has appeared. Further, the anatomical characters of the Lansing man are not distinctly different from the known American types; if they had so differed we should have had at least one argument for their antiquity.

Some writers have given undue weight to the fact that all the skeletons so far presenting claims to antiquity are of the American Indian type and so can not be ancient. This is really a fallacy, for while the presence of a distinct morphological difference would be one good argument

for a respectable antiquity, the absence of such differences would not be equally good evidence against it. Thus in Europe we find an early type known as the Crô-Magnon, which has its close parallels in the present population. Then the indisputable unity of the whole American race from north to south leaves us no choice but to conclude that its ancestral stock came from one source, and that from the start its fundamental somatic characters were delimited. There are good faunistic reasons for believing that America received its population from Asia at a period comparing to the Paleolithic of western Europe, and that since the late Neolithic has remained in almost complete isolation. According to these interpretations, there is no reason to expect that any of our skeleton finds, however ancient, will show decided differences from the surviving types. These conditions rob us of one method by which a definite conclusion could be formed as to the antiquity of random skeletal finds. About the only anatomical check we can expect is in case such finds can be identified as belonging to local historical tribes, but even here we must proceed with caution, for the great persistence of local types in Europe indicates the possibility of the long continuance of initial types in the same habitat.

European investigators have achieved their greatest triumphs from discoveries of the débris of human cultures, but similar deposits have not yet come to light in America. The claims of Abbott, Volk and others have been based almost entirely upon random finds of stone or bone worked by man. The American literature of some twenty years ago is curiously characterized by affidavits and sworn statements, as to the exact place, position, identity, etc., of the single objects found. This itself effectively demonstrates the insufficiency of the data. While theoretically the finding of a single stone implement in an interglacial deposit would prove the contemporaneous existence of man, its very unverifiable nature would make it of little scientific worth, and the necessity of depending entirely upon the mere assertions of an individual would leave us no recourse but extreme skepticism. In contrast to the interglacial deposits of culture débris in western Europe, these random American finds too strongly suggest errors in observation and natural accidents of deposition to afford a basis for any kind of scientific or mere speculative structure.

It is true, of course, that the mere accumulation of these observations, isolated though they be, adds greatly to their weight and will, if long continued, give a sufficient basis for some kind of an interpretation. The only part of the country from which such an accumulation begins to appear is the Pacific coast of the United States, where Professor Merriam cites at least eleven different finds in Pleistocene and earlier formations. But notwithstanding the obvious fact that, given enough time, a very respectable series of artifacts may come to hand from the gravels of the Pacific slope, the difficulty of correlating them and of interpreting the

culture of the period is still very great. The experience with European deposits is decidedly against the successful use of such isolated finds. It seems a safe prediction that unless the original culture deposits can be found in the Pacific coast area, faunistically or otherwise dated, we shall always find it necessary to maintain a more or less skeptical attitude toward the antiquity of these isolated finds, even though they be of great number.

One difficulty we have not yet stated is analogous to that encountered in skeleton finds: viz., the lack of distinct differences between these supposed antiquities and objects found on the surface of recent village sites. As in case of skeleton material, the fact that certain differences can not be observed is no good reason for doubting their antiquity; it simply leaves us with an even chance that their presence in all geological strata is intrusive. The crucial point is that, notwithstanding the vast amount of searching by archeologists, amateur and otherwise, nowhere within these United States and Canada have we record of a culture deposit that clearly precedes or accompanies the last period of glaciation. As to what the future may bring forth no prediction is safe. It is probable that if the auriferous gravels of California do have human relics, stratified deposits will ultimately appear. This part of the country is still but newly occupied and may in the near future reveal rock-shelter deposits of undoubtable antiquity. On the Atlantic seaboard and in the limestone cavern area of the Mississippi Basin, there is much less reason to expect new discoveries, for the ground has been worked over with considerable care. The only site about which even a strong presumption of antiquity can be raised is at Trenton, New Jersey, where Dr. Abbott, and later Putnam and Volk, made certain observations, upon the basis of which a theory of stratification has been advanced. The Trenton site presents first a black sandy soil of some two feet in depth, below which is a layer of yellowish sand from one to three feet and resting upon gravels. In the black soil were remains clearly identified with those of the Delaware Indians, formerly occupying the vicinity. In the sand disconnected with the soil were random stone implements. By dint of long and patient search Mr. Volk discovered in the gravels beneath two fragments of human bones and one or two problematic pebbles, suggesting human workmanship, but not positively. On this basis Putnam assumed three culture periods for the Delaware Valley, the oldest preceding the last advance of the ice, the second during the final retreat of the ice, and lastly the historic period.

It will be noted that the data for the first period consist of little more than a single find and, as may be expected, have been looked upon with extreme skepticism. No faunistic associates were found in the gravels except a fragment of a scapula, which may be musk ox, though it can not be positively distinguished from bison or even domestic ox.

Altogether these are not adequate data for establishing a culture period. Fifteen years of subsequent observation by Mr. Volk have failed to bring anything more to light, and also, since it is not clear that the gravels in which these bones were found were undisturbed by post-glacial floods, we must consider the case as far from proved.

This brings us to the middle sand layer, which enjoys the distinction of being the only archeological find so far reported that has a fair claim to antiquity. Mr. Volk ran a series of trenches in one part of the site, discovering some fragmentary human bones and a number of stone implements. The variety of artifacts indicated a cultural difference from those found in the black soil above and as they appeared to be made from argillite, the assumed culture was designated as Argillite culture. After this definite result Mr. Volk did not trench further, but rested his case.

Mr. Volk's claim for the antiquity of this layer was generally rejected on assumed geological grounds. In brief, it was regarded as a wind deposit of comparatively recent formation, most of the artifacts having merely "settled" down from the black soil above. Failure to meet either of these objections would waive all just claim to antiquity. As no further trenching was reported, the case necessarily stood as not proven and interest in the site was lost.

After an interim of about ten years, Dr. C. C. Abbott, owner of the site and its original discoverer, invited the American Museum of Natural History to reexamine the deposit. This resulted in a more systematic investigation which gives us data of a more positive kind. The trial trenching was carried on by Mr. Alanson Skinner and the stratigraphic work by Mr. Leslie Spier. The report of Mr. Spier fully agrees with Mr. Volk's observations, but presents some new problems. Mr. Spier discovered that the vertical distribution of the artifacts in this yellow sand took the form of a normal frequency curve. It was then possible to compare with precision the series from the various trenches and also with the former data of Mr. Volk. By this triumph of method it was shown that through the deposit extends one plane of maximum frequency around which the artifacts fall in a normal frequency curve. Pebbles of appreciable size were found in the sand and two series for these showed that they also had the same frequency curve with approximately the same average. In other words, the series for artifacts is the same as the pebble series, the former being but worked pebbles. Hence, the same agency that deposited the pebbles also deposited the stone implements. While man could have carried the artifacts and dropped them on a wind-growing sand dune, it is inconceivable that he should have carried the pebbles, for they are many times more numerous than the worked stones. Further, a recent study of known wind and water deposits by a geologist shows that the normal frequency curve for

coarse grains of sand is characteristic of water deposits, but not of wind-carried material.

Therefore, the archeological brief for this case may be said to be in. It shows artifacts of stones deposited in a definite way agreeing with our present knowledge of water deposits. These artifacts are distinct from and below the cultural débris of the Indians living here at the discovery of America, and are therefore older. The age of the deposit is a geological problem which awaits further investigation, but as a water deposit it must be not later than the last recession of the ice from Northern New Jersey.

While this case has thus come to a definite pass and stands so far as the best evidence for an ancient culture in America, it still presents some of the characteristics noted at the outset. It also is in a sense a random deposit of isolated specimens, selected and carried by a natural agency. Under such conditions the cultural association of the objects can not readily be determined, and until a camp site of this culture is uncovered and identified there will be a general hesitancy to accept the result noted above. The case of the Delaware Valley is thus about the same as that for the Pacific coast, and in contrast to the condition in western Europe, where we have definite camp deposits, is rather disconcerting. At least it presents a serious problem that calls for new methods and far less slipshod field-work than some of our professed anthropologists have perpetrated in the past. On the other hand, local collectors in every part of the country should be encouraged to put their discoveries on record, even their isolated finds, and to examine all cuts and excavations in the old river terraces of their respective communities, because the accumulation of even isolated finds may ultimately pilot us to the long sought original deposits. As in Europe, the solution of the problem will depend upon the joint efforts of individuals residing in many localities and not upon the work of a single individual.

CHANGSHA AND THE CHINESE

By Dr. ALFRED C. REED

SAN FRANCISCO

PERHAPS to western eyes no feature of the seething life of the orient presents so strange and unexpected a contrast, so weird and startling an experience, as a first entrance into a Chinese walled city. China is to-day a land of contrasts, where the west and its civilization is sharply juxtaposed to the most ancient and conservative east. Like a wasp's nest a walled city from outside betrays no part of the swarming host within. A plain gray stone or brick wall alone is visible, so near the earth color that it is hardly to be separated from the other features of a monotonous brown landscape, were it not for the notched summit, an occasional gilded roof within, and the better view afforded where a chance hill may lift the wall into full perspective. In this latter case it stands out grim and suggestive of the age-long resistance of inertia, the colorless passive indifference of the race that fashioned it.

But this old Chinese wall has other qualities. Its fifteen to thirty feet of height and its solid ten to fifty foot width may represent the inertia and egotistic passivity of its makers, but they represent with equal truth those factors which have preserved the racial integrity of the Chinese and made them conquer their conquerors time and again through history, by extending apparent defeat into a slow process of absorption and assimilation. If the first view of the walled city reveals only the wall, and that in its somberest, most uninviting colors, so does the first contact with the race show only the instinctive racial opposition and contempt, the masking stolidity, indifference and hostility which surround like a grim gray wall the qualities of humanity, altruism and receptivity which are found in the Chinese at their best.

But now to leave the rich countryside, the broad winding river, the clumps of bamboos and camphor trees, the grave-covered brown hills, and the valleys and low places with their crowding paddy fields and vegetable patches—and to enter the tunnel-like runway with its massive iron gates which leads through the wall into the city. Once inside, a new world, strangely different from any other world, swallows up the spectator. The street is narrow, perhaps not over ten or twelve feet in width, and filled with a confused swarm of Chinese. No sidewalks, no horses, no carts, wagons, automobiles or street cars have any place here. Instead, coolies with baskets hanging from poles across their shoulders, wooden-wheeled barrows innocent of grease, rattling iron-tired rickshaws, an occasional sedan chair, multitudes of pedestrians, and underfoot dogs,

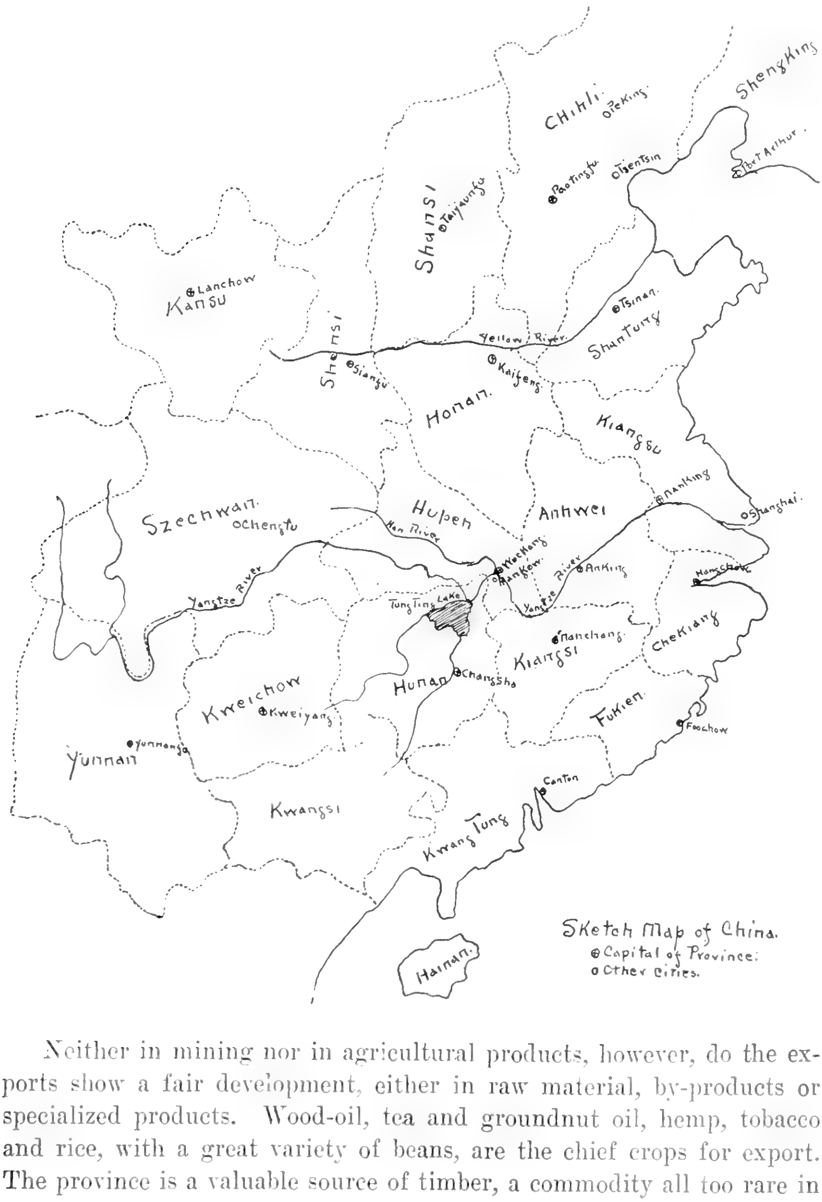
many pigs and children in all stages of dress and dirt—this fills the scene. Little sunlight penetrates the narrow crooked street, because from the one- and two-story buildings on either side, matting, thatch and bamboo awnings almost completely cover in the tunnel-like cañon. Then too the perpendicular hanging scrolls and cloths which replace the western advertising signs, help shut out the light.

In such a scene does one find himself on entering Changsha through almost any one of its eight gates. Before going on to describe more minutely the strange drama of life within this great and wealthy old city, it may be well to orientate Changsha in place, time and interest. The geography of China has been recarved within the past few years. A glance at the accompanying sketch map will show that the eighteen provinces of China proper form a rough circle surrounded on the one side by the sea and on the other by the wild, desert-like, largely unexplored subsidiary territories of Manchuria, Mongolia, Sinkiang and Tibet. Looking again at the eighteen provinces, it is seen that the province of Hunan is but slightly south and east of the real center of China. The district of the eighteen provinces is divided into three parts by mountains extending in a general east and west direction, separating the valley of the Yang-tze river in the middle from the valley of the Hwangho to the north, and from the southern tier of provinces, Yunnan, Kwangsi, Kwangtung and Fukien, on the south. Hunan is thus not only near the geographical center of the provinces, but it lies in the central one of the three great physical divisions of China, and about midway in the course of the great Yang-tze through China.

The only approach to Hunan is through the valley of the great river, although the Peking-Canton railway, now under construction, will open a route directly south through the mountains to Canton. Hunan province, comprising a territory of 84,000 square miles, an area about equal to Kansas, has some 22 million people. Half of the province is occupied by the valley of the Siang river which flows into the Tung Ting lake in the north of Hunan, the largest lake in China. This river valley has extreme fertility and is densely populated. The upper half of it is tributary in trade to Siangtan, a city of 400,000 about thirty miles above Changsha. The head of navigation for the larger river steamers on the Siang is Changsha, 200 miles above Hankow. Except for the term of low water in January and February, large vessels can reach this point with ease the year around, and a regular daily passenger service is in operation between the two ports.

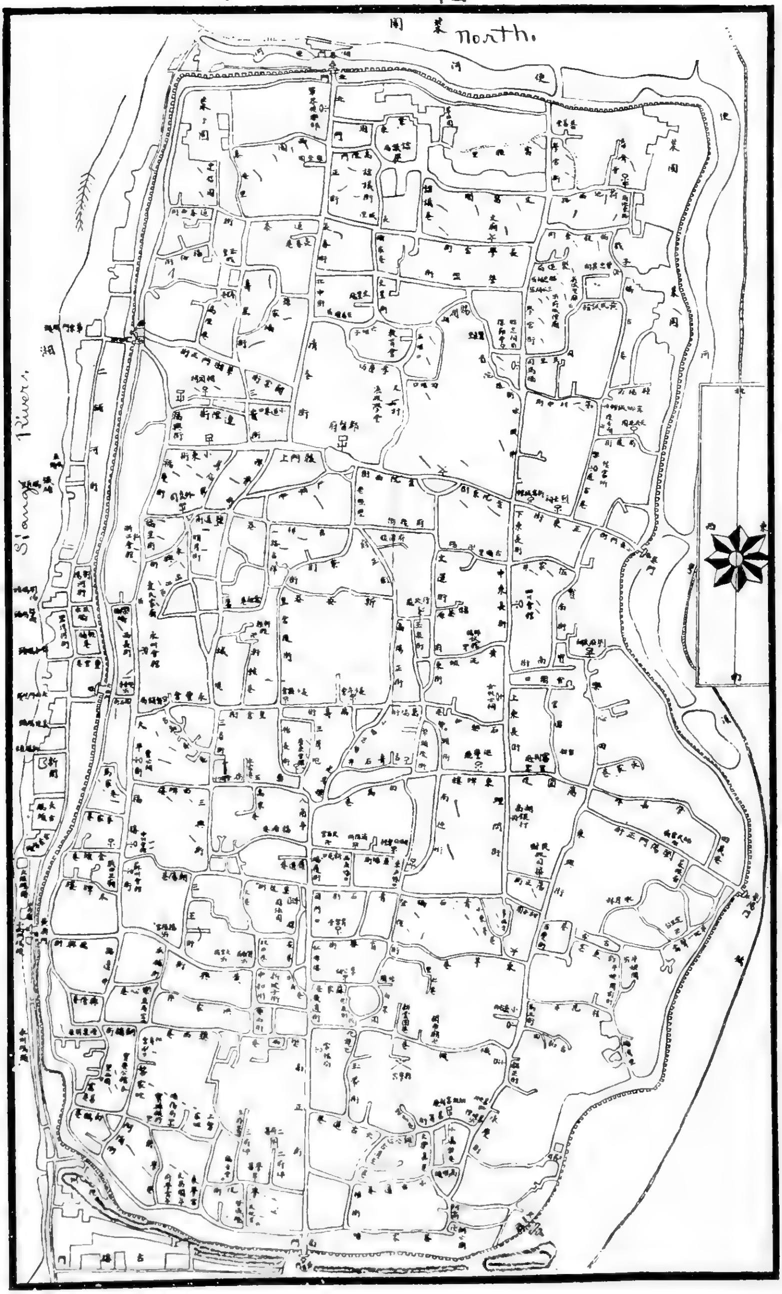
Hunan is a mining and agricultural province, but the mineral resources have been so far scarcely more than scratched. The mountains of the southern half contain enormous deposits of coal, chiefly bituminous, but with some anthracite, as well as abundant limestone, iron, copper, tin and antimony, and to a smaller extent lead, manganese and silver. The

Hunan antimony deposits are among the richest in the world. The Huachang Smelting Company in Changsha has a capacity of ten tons per day of this metal. The original plant of this company was imported from France and yielded but two tons a day, but the machinery was copied and enlarged in Changsha by native workmen to its present capacity. The establishment of two new antimony plants in Hunan is now under consideration.



Neither in mining nor in agricultural products, however, do the exports show a fair development, either in raw material, by-products or specialized products. Wood-oil, tea and groundnut oil, hemp, tobacco and rice, with a great variety of beans, are the chief crops for export. The province is a valuable source of timber, a commodity all too rare in

湖南省城全圖



THE CITY OF CHANGSHA.

China where the short-sighted policy of indiscriminate deforestation causes the most disastrous floods the world knows. Even here no systematic reforesting is encouraged or practiced. Large rafts are made up at certain points on the Siang river where the pine, fir, laurel, camphor and other logs are collected from the various tributaries. These rafts, which are really floating villages, go down the river with the current, and the timber is distributed throughout the Yang-tze valley. The bamboo grows wild over the mountains of Hunan and is sent out of the province like other timber. Its smoky, feathery foliage, interspersed with an occasional camphor or palm tree, is one of the most beautiful sights observed. The bamboo shoots attain their maximum height in the first season and later years merely add to the thickness of the stalk. The bamboo in its first year rivals the banana in rapidity of growth.

Hunan produces a large cotton crop, especially in the northwestern section. The original seed came from America, but the stock has depreciated and the cotton is of very inferior quality. It can be bought in the street market for about ten cents gold per pound. Tobacco too is raised in large quantity, but its quality is poor. The Chinese is a prodigious smoker, at least in so far as pertains to the time spent on the habit. In Changsha the large, cumbersome water pipe is universal and indispensable for every class of society. A small wisp of tobacco shavings is placed in the bowl of the pipe, ignited with a fuse which is blown into a flame, and the smoke is inhaled at one or two puffs. The process is repeated ad infinitum. The pipe is passed around in every group of men, and women too, and each takes a whiff. For those exceptional ones who are too busy to manipulate their own pipes, a special public pipe with a long stem is available. This is carried about by a street vender, loaded with a wisp of tobacco, lighted, and the stem put into the mouth of the customer who takes his whiff without taking his eyes or attention from the matter in hand. A slender straight pipe is also used and cigarettes are increasingly frequent. The women and girls enjoy the pastime as much as the men, and in a land where everything is upside down or backwards, the custom seems neither strange nor unseemly.

The poor quality of cotton produced illustrates the entire ineptitude of the Chinese on his native heath or rather paddy field in introducing new or improved methods or agricultural products. Changsha is adapted in soil and climate for all sorts of citrus fruits, but the oranges are of the poorest, the best obtainable being imported, and foreign lemons are unknown. The native lemon is a large, coarse, slightly bitter fruit. Grape fruit are not found, but pomeloes are abundant and occasionally quite good. Even where good orange and lemon stock has been introduced, the farmers will not give proper care or learn better methods of production. The result is a rapid deterioration of imported stock and an extremely poor grade of native stock.

KULING MOUNTAIN, Summer Resort of Foreigners.

Of the rich and central province of Hunan, Changsha is the capital, lying in north latitude 28 degrees and 30 minutes, about even with Tampa, Florida, and 800 miles inland from Shanghai by river. It is the largest city of the province, having a population somewhere between three and five hundred thousand, and ranks among the oldest, wealthiest and best built cities of China. The Siang river gives it free communication by water with Hankow and thence by rail and water with Peking and Shanghai. The water life of China is among its most picturesque features, and the Changsha bund furnishes a kaleidoscopic review of the incoming and outgoing traffic. This city is fortunate above most Chinese cities in having near at hand very extensive quarries of excellent granite, which, cut in huge blocks, sixteen inches wide, six inches thick and from three to six feet long, supplies paving for the streets, building material for many of the more modern edifices and a lasting fabric for the sea-wall which protects the city and its bund from incursions of the river. This wall extends for three miles, averaging between twenty and forty feet in height and at frequent intervals having broad granite steps leading down to low-water level, so that, as the river rises, the boats merely come alongside a higher step. The large river steamers from Hankow and way-ports are docked alongside floating hulks which are anchored and chained in the deep water off the bund. From the hulk which acts as a landing stage, ticket office, freight depot and waiting room combined, a pontoon foot bridge leads ashore. These hulk-docks are characteristic features of the Yang tze steamer system.

Chinese river life is a world in itself, and the Changsha bund presents a never-ending and constantly changing panorama of water craft and river population. The great lumber rafts pass here, many a hun-

dred and two hundred yards in length, with their thousands of logs bound together with split bamboo withes, and surmounted by the thatched huts of the numerous crew and their more numerous families. The whole unwieldy mass of logs or bamboo is propelled in a variety of ways and at an infinitesimal speed. For time, like human life and labor, is of no account in China. Sometimes a long woven bamboo or hempen cable is stretched ashore ahead, and from twenty to fifty men pull. If the wind favors, a multitude of sails, large and small and of all colors, springs up in a variegated crop. Sometimes a huge sand anchor is fixed in the mud several hundred yards ahead and by means of a creaking wooden windlass, the raft is drawn up to it. Thus the rafts are taken up stream as well as down. There are also men and boys punting with bamboo poles, and innumerable sculls, working sampan-fashion, with often a half-dozen coolies swinging on one oar. The sampan oar is a curious affair and the Oriental method of rowing, the oarsman facing forward and standing erect, with short quick choppy strokes, is totally different from ours.

The Chinese houseboat is a commodious flat-bottomed structure with blunt ends, a high galleon-like stern, a tremendous sail-spread for a draught of but two or three feet, and it general style of architecture might well be descended from the time of Noah. Like all Chinese boats, the houseboat is provided with a pair of brightly painted eyes, else how could it see to make its leisurely way through the thronging fleet of river craft? In the junk and houseboat the steersman sits under an arching roof which covers in the stern and permits no vision to the sides or forward. He steers by land-marks astern and has an uninterrupted view of everything he has passed. This system works very well in the day time when other members of his crew or family are watching ahead, but at night it is not so successful and the situation is aggra-

TRAVELING IN THE COUNTRY MOUNTAIN CHAIRS, passing a paddy field.

vated by the entire absence of lights. Unlighted junks with only the steersman awake and no look-out ahead are the bane of the river steamers above Hankow and collisions are frequent.

Another feature of the water life is the cormorant fisher. This individual owns a sampan with a long fore and aft roost, on which are perched from five to twenty cormorants. Each bird has an iron ring around its throat which is just tight enough to keep it from swallowing a fish. The birds dive overboard, catch the fish and are hauled back with the prey in their mouths. Of other river industries, mention must be

TOMB AND SHRINE NEAR CHANGSHA

made of the duck farmers. It is no uncommon thing to see a solid mass of ducks, like a great raft, go quacking by, the column being held in shape and steered by a couple of sampans whose owners beat the water with long slender bamboo rods, and frighten the ducks into the straight and narrow path to market. Some of these flocks number from five to ten thousand birds, and so tightly are they wedged together that when an occasional duck is squeezed upon top of the main layer it must scramble to the edge of the flock to get its feet into the water again.

The Changsha city wall is about five miles in circuit and its broad summit provides barracks for many troops. The outer edge is raised into a granite and brick escarpment or parapet, from four to ten feet

higher than the level summit, through which numerous embrasures allowed the defenders to manipulate their artillery under protection from an enemy's fire. These old guns are dismantled now, but hundreds of them cast in various parts of Europe as well as China, are lying about, eaten with rust, and disregarded. Like most city walls, this one has an outer and an inner wall of brick or granite, and the intervening space of ten to eighty feet is filled with dirt. One old cannon is still mounted on the wooden trucks from which it helped defend the city against the Taipings. This is the gun which killed the Taiping general and a shed has been placed over it, together with an inscription telling why the people still worship it.

History states that Changsha was founded during the Han dynasty, one of the most glorious in Chinese annals, which flourished from 200 B.C. to about A.D. 200. The original wall has long s'nce succumbed to

GRAVE-COVERED HILL AND A FARM HOUSE.

siege and assault, and there is little about the city except its graves to bear evident witness to its antiquity. It is almost unique in never having been pillaged or looted. As the capital and largest city of Hunan it attracts many of the wealthy class and the gentry, who select it as a desirable place of residence. Since being made a treaty port, the foreign community has steadily grown, until now there are over 200 Americans, British, Germans and other Europeans resident in the city or on the long sandy island lying in the river opposite. It is from the three-mile length of this island that the city takes its name, Changsha, or "long sand." On the island are the British Consulate and the residence of the commissioner of customs and other foreigners.

Great Britain, Germany and the United States maintain consulates in Changsha. The foreigners in the city are divided between the thirteen missions, seven German firms, five British, two Japanese, and one

AN EMBRASURE ON THE CITY WALL.

each American, Belgian and French. The American hong or business house is the Standard Oil Company branch, which is easily holding its own against its powerful oriental rivals. In 1913 a half of the total importation of kerosene was American, Changsha has a Chinese and a Japanese post-office.

Across the river from the city rises the beautiful wooded hill of Yolosan. With an altitude of but 800 feet above sea level at Shanghai, this mountain still gives a magnificent view over the hilly country on every side, and the river and city at its foot. On it is a large stone tablet, the Yu Pei, which recites the tale of the mastery of the vast floods which once inundated enormous sections of central China. This tablet was erected by the great Yu, founder of the Hsia dynasty, 2205 B. C. On the southern slope of Yolosan is a large high school, in which are Confucian and Buddhist temples. The mountain is heavily timbered from here to the Taoist temple on the summit.

Changsha is an educational center of importance. It boasts about thirty prominent schools, most of which are public and are maintained at least to a considerable degree by the government. It is to these schools that the people of the entire province look for an opportunity to study western civilization and methods. The Changsha educational system has an influence on 22 millions of people and is a controlling factor in their leadership and views. In this connection it is of course to be remembered that even in these so-called modern schools the old Chinese idea prevails, that the students and not the faculty are in control, and that a superficial smattering knowledge is too apt to replace genuine, thoroughgoing scholarship. These Chinese cares more for appearance, for a smooth and glittering surface, for an apparent acquaint-

ance with western learning, than he does for the genuine substrata that alone make possible the real western civilization. These traits appear just as prominently in the educational system as they do in the industries, the government and the ordinary every-day life of the people.

In Changsha are five normal schools, one called a high normal school and the others simply numbered from one to four. The latter prepare teachers for the primary schools, while the high normal fits them to teach in the middle schools. Board and tuition are provided free and the enrollment in each is about 400. In the high normal the average student age is twenty-two years; in the other four it is about nineteen.

The largest, and in popular estimation one of the best, of the middle schools is the Chang Tsuen, with an attendance of 1,200 students. Here too the tuition is free to Hunanese. Next in size are the Hunan Provincial Middle School and the Ming Teh School with 400 students each. The average age in these is sixteen years. The Higher Technical School of Hunan has an enrollment of 900, averaging twenty-one years of age. With lower requirements, are the middle and primary technical schools. In these are offered such courses as railroad and civil engineering, mining, architecture, chemistry and physics, and their laboratory equipment is fair. There are two commercial schools with 200 students each where business correspondence and book-keeping receive major emphasis.

The University of Hunan, with 400 students, makes a specialty of Chinese and foreign literature, politics and law. A railroad school, supported by the provincial government, has 600 students. There is too a school of communications, attended by a hundred boys, whose time is spent chiefly on the Tibetan and Mongolian languages. A police school, enrolling 500, prepares for positions on the police force.

Roof Scene, showing flat tiles and "Saitai" or roof platforms for drying clothes.

CHANGSHA BUND.

There are a dozen institutions giving instruction in politics and law, and they are well attended, for the Chinese ever has an impelling desire to become a public official and fatten off the land. A school of agriculture has 400 students, and in the future ought to be influential in improving this industry. Eight free primary public schools are maintained for both boys and girls. The average age in these is nine years and each school has about 250 pupils. Changsha has in addition about a dozen girls' schools with free tuition and each divided into three sections, normal, preparatory and primary. Chief emphasis is put on the study of Chinese and a counterpart in name at least of our own "domestic science" courses, the girls learning the various household arts and crafts.

Practical education is not an end in itself with the Chinese, but is merely auxiliary and always subsidiary to moral development. At least this is the attitude assumed in regard to it. But the educational system, like many other things Chinese, makes an imposing array on paper and in reports, while, judged by its efficiency and its output, it is a weak and inefficient institution. The old Chinese classical system has gone out, but so far the new learning has left only a surface mark and has in no sense filled the abyss left by the destruction of the old. The formulæ and the symbols are found, but the spirit and the scholarship have not yet taken root.

Life in the midst of a Chinese city offers many distractions to a mind bowed down with the weight of domestic woes and misunderstanding servants, the unbelievable difficulties of the currency or lack of currency, the unlearnable language, and all the multitude of vexations and torments which like a cloud of greedy mosquitoes, seek the fresh blood of the newcomer.[1]

[1] A. C. Reed, "New York to Changsha," *Pomona College Alumni Quarterly*, June, 1914.

Not contented with one coinage, the industrious Chinese has several kinds, in fact many kinds, and practically none are current beyond a more or less restricted district. Usually the Mexican silver dollar is good anywhere, unless it is filled with lead, or counterfeit, or "chopped," one of which conditions usually prevails. Each province issues dollars and they are variously discounted by other provinces. Another unit is called the tael, which is supposed to be a definite weight of silver, no coin being minted of this value, but even this standard varies from time to time and from place to place. The daily business of the people is conducted entirely in "cash." Paper cash exchange fluctuates widely, a dollar being worth from 1,300 to 1,800 paper cash. The paper cash and cash notes have been abolished in Changsha in favor of the copper cash. Each copper is worth ten cash, but the exchange rate again varies from 1,300 to 1,600 cash per dollar. A great obstacle to monetary reform in China is the banking and money exchange class, which makes a fat living off the exchange and is loath to see its profits disappear with a stable currency.

The Chinese language too is a topsy-turvy thing, differing radically in its construction and expression from anything western. Many years of hard study are necessary for a foreigner to gain a working knowledge of it. Chinese from neighboring localities are frequently entirely unintelligible to each other. The language is devoid of grammar, rule and reason: innocent of syntax and logic. It has a varying number of tones or inflections which are as essential in pronunciation as the word itself. The Hunanese are blessed with but five tones, but in Kwantung and Szechuen there are eleven. In Hunan there is a level high tone, a level low tone, a falling tone, a high and a low-pitched rising tone. To ignore tone is never to learn Chinese. The same word in a different tone has a totally different meaning. It is a language which children

A Temple Court.

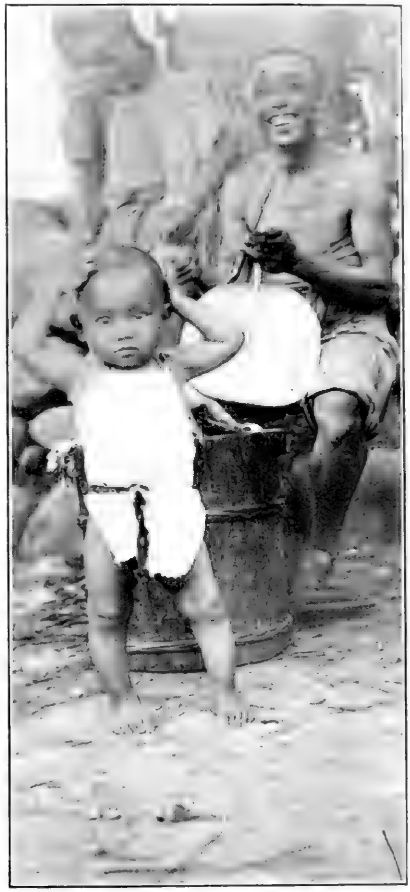
AN AIRING IN THE CITY.

learn to speak easily, but which adults must study with the help of a musical scale.

When tone and syllable are correct there is the further matter of aspiration to be remembered. Whether to aspirate or not to aspirate is a question of equal importance with that of proper tone. Having learned several thousand words, all of which are monosyllabic and in Hunan ending with a vowel, there is the difficult subject of idiom to be mastered. On the proper arrangement of words in the sentence depends its intelligibility and often its meaning. Chinese idiom is a bug-bear few foreigners successfully overcome. For instance, having found the right words, and given them correct tone and aspiration, imagine an idiom which in order to say, "I am afraid the young gentlemen will not be pleased with me," says literally, "Apprehend fear young sir see not up I this piece man." Again for our generic word "thing," the Chinese says, "one piece east-west." If in desperation one falls into the horrors of "pigeon-English," still is to be remembered the remark of an applicant for the position of cook in a certain foreign family in which were seven ladies and one gentleman. The would-be cook on learning this astonishing fact, said in good pigeon-English, "One piecee he, seven piecee she, too muchee she, no can do."

Of the thirteen missions in Changsha, there is one which represents a unique and typically American movement, whose spirit and idea is engaging the interest and active support of a rapidly widening group of people. This is the Yale Mission, a movement founded and supported by an incorporated society of Yale alumni and faculty, and established on certain fundamental principles whose recognition in university circles is distinctly modern. These principles take account, on the one hand, of the critical need in China to-day of certain qualities and a type of men which Christian western civilization can produce, and, on the

other hand, there is due recognition of the unique opportunity of a great American university to supply this need in a most practical and statesmanlike manner. The movement gathers enthusiastic support from a widening circle of men and women of large philanthropy and missionary zeal in the broadest sense of the word.



SUMMER COSTUME. TEMPERATURE 110°.

Yale-in-China has no evangelistic activities. It is not entering on the field of the established missionary organizations. It is not in rivalry with the church movements. It is not isolated from the spirit of modern missions. It is, contrariwise, in most cordial agreement and sympathy with every activity seeking the moral, physical and spiritual betterment of the Chinese, and it has the cooperation and support of the established societies. It is not duplicating the work of others, nor crowding an old field of activity. It is entering a field previously untouched and giving to the Chinese of Hunan the best spirit, methods and Christian culture of the best type of American university, and giving to a growing number of American university men and women an opportunity for practical benevolence with no restriction of creed, dogma or self-intere t. So attractive is the idea of this movement that it has already been copied in other universities and is forming a recognized form of modern social service and benevolence.

The work of Yale-in-China is two-fold, educational and medical. Or better, its work is purely educational, in two lines, academic and medical. In the ten years of its history to date, a carefully graded and fully staffed college preparatory department has been established, from which four classes have been graduated. The first freshman class in the college department entered in the fall of 1914. There are now 200 students and a faculty of eight Americans with a large staff of Chinese instructors. Practically all the instruction is given in English, except the first two years. An increasing interest is shown by the Yale boys in

Medical Staff and Graduate Nurses of Yale Hospital.

things athletic, and under competent coaching they usually sweep the field in the interscholastic and provincial field-meets held in Changsha. A modern gymnasium is badly needed to supplement and facilitate the present courses in physical culture. The Chinese student is typically of defective physique, poor muscular development and with a strong predisposition to circulatory and pulmonary diseases. When given the opportunity, however, he takes as eagerly to athletic sports as his western brother of the American universities, and there is an immediate and corresponding improvement in his scholarship and his physique.

The Yale medical work comprises an extensive plant. Two hospitals are maintained, the Yale Hospital of 75 beds for women, and the Red Cross Hospital of 100 beds for men. Each hospital has a good clinical laboratory and operating equipment. At the Yale Hospital are the offices of the medical staff, the library, printing press and research laboratories. Each hospital has a modern pharmacy. The medical staff numbers six physicians and will be increased to ten within the near future. Two nurses' training schools are in operation under the supervision of two American graduate nurses. Regular instruction is given in both schools, for men and women, respectively, in practical and theoretical subjects.

At the initiative of the Chinese, arrangements have now been made for a definite contractual agreement between a Chinese corporation and Yale for the support of a modern medical college. The Chinese are furnishing land, school buildings, and money for operation, while Yale is to furnish the staff. Finally the China medical board of the Rocke-

feller Foundation has given the salaries of six new teachers in the medical college. This opens limitless possibilities and is the first co-operative movement of the sort to be instituted in China. The plan, moreover, has the hearty endorsement and support of the Peking government.

The Yale medical and educational work is temporarily housed in Chinese buildings in the center of Changsha. But within a year or two the entire plant will be moved to the fine new campus just outside the north gate of the city. The new buildings are now being erected there under the direction of an American architectural engineer. A new modern hospital of 120 beds, to be one of the best equipped in Asia, will adjoin the new Yale campus. The hospital will cost about $200,000 and will be especially fitted for the practice of modern medicine and surgery, for research and for teaching.

Changsha is coming to be a commercial center for Hunan. The development of export and import trade in central China is of very recent origin. Heretofore each province has imitated China as a whole in attempting to restrict buying and selling to purely domestic transactions. So there are still found inter-provincial customs barriers, and all too often, embargoes on the exportation of rice or other staples from one province to another. These feudal traits are rapidly disappearing as the country enters on its era of railroad building and as western men and methods become more influential.

Changsha manufactures in large quantity furniture, gold and silver articles, and coarse paper. Much pewter of varying grades of hardness is made from locally mined tin and lead. The ordinary grades have equal parts of tin and lead or two parts tin to one of lead. A

A GROUP OF CHILDREN, patients in the Changsha Yale Hospital.

harder pewter is made by the addition of copper and antimony. Tin is extensively used for all manner of cooking utensils, water and oil cans, stove pipes and similar articles. Large quantities are also used for lining packing boxes and storage chests for summer, when it is necessary to protect against the dampness and heat, when mould covers shoes and gloves over night, and only the essentials are left out of the sealed tin-lined cases.

The first year of the republic was one of exceptional prosperity in Hunan and the general trade of Changsha improved correspondingly. For the year 1913, the Chinese customs report showed merchandise movements totalling taels 22,038,368, or about $306,088 United States gold. The increasing popularity of foreign-style houses was shown by a 50 per cent. increase in the importation of window glass. The copper supply is chiefly Hunanese in origin and comes to Changsha in the form of copper ingots to be worked up in the local mint into ten-cash pieces. Changsha exports may be divided into various groups. First among these come articles bought by foreign merchants for export abroad, such as ores and metals; white, yellow, green and broad beans; pig bristles; fresh eggs; feathers, hemp, hides, nut-galls; tea and wood oils; vegetable tallow and varnish. Second are articles exported by Chinese firms for domestic use, such as arsenic, bamboo shoots, black beans, coke-preserved eggs, fire crackers, grass-cloth, lard (to the Chinese in Straits Settlements), lotus nuts, medicines, nankeens, inferior paper, steel bars, tobacco and paper umbrellas. The third class includes articles bought by Chinese merchants for sale to foreign merchants in other lines, such as fire crackers, human hair, hemp, tea and tea stalks. A large proportion of the enormous production of fire crackers in Changsha finds its way through Canton to America for the Fourth of July.

Changsha has always been a hot-bed of rebellion and political unrest, but the purely local disturbances of the last five years probably owe much to Japanese instigation. The Japanese are throughout China and their influence is a constantly growing peril of the future. In June of 1913, Hunan declared its independence, but vigorous and effective measures taken by Governor Tang, a new appointee of President Yuan Shih-kai, and his 3,000 northern soldiers, very completely destroyed all illusions in the minds of the Hunanese as to their integral share, not only in the benefits, but also in the burdens of national and racial China. Governor Tang has had several years' residence and study in France and his acquaintance with western civilization makes him a strong factor in restraining the powerful reactionary element and in moderating the excessive zeal of the progressives of the half-assimilated western learning cult. In this as in most of China's political disorders, the common people have had little part and less interest. So near does the coolie or farmer live to actual starvation, and so tenuous is his margin

of safety, that he has neither thought nor interest for any affairs not connected with his daily toil for actual food. He cares not who rules, nor how well or wisely, unless his own little sphere of daily activity is jarred. When it is, there are disturbances of a widespread and iconoclastic nature.

Illustrative of this fact were the last riots which occurred in Changsha in the spring of 1910. The cause was not primarily an anti-foreign sentiment, but the lack of rice and the high prices to which the available supply was forced. The people blamed the governor for having permitted exportation of rice to other provinces, with good Chinese logic ignoring the inherent fallacy in the supposition that exportation of a staple article begets an unsatisfiable demand for it. As so easily happens with the conservative ignorance of this race, such an economic necessity immediately took the form of anti-foreign hostility. A demonstration against the governor's yamen thus turned almost naturally into genuine rioting at the mission compounds and the custom house. The Norwegian, Wesleyan and Catholic missions and the custom house were burned. The governor having fled, the lower provincial officers did not stop the rioting for two days. Foreigners were not attacked, but much property was destroyed, for which indemnity was later paid, the rioters never being punished.

To understand the Chinese character and to arrive at some reliable method for forecasting China's future, it is essential that several component factors be recognized. First and chief among these is the record and influence of the past. Nowhere do custom and precedent have such complete mastery as in China. The central element in Chinese life is reverence and obligation to ancestors. Indeed Maeterlinck's spirits of the dead would be constantly vivified in China, for the Chinese have them ever in mind. This sentiment is extended also to the ancestors' words and deeds. The critical weight of history and precedent in determining the reaction of the Chinese mind to a certain stimulus can not be exaggerated. The second factor is the condition of China in respect of religious beliefs. As Bland puts it,[2]

> There is the courage of an endurance almost superhuman in the lives of China's toiling millions, but the pathos and the poetry of a religion which redeems other Asiatic races from the heaviest penalties of materialism, have been sacrificed in Confucianism to the worship of genius, to an ethical system which contents itself with defining man's relation to man, and leaves him without enthusiasms, almost without curiosity, for the inner life and mysteries of worlds unseen. . . . The unity of the family and the state, the worship of ancestors, the three relations, and the paramount duty of labor,—these are the unshaken tenets of the Chinaman's creed, the sum and substance of his philosophy and religion.

The third factor embodies the present economic and sociological

[2] Bland, J. O. P., "Recent Events and Present Policies in China," p. 19.

condition of China. The overcrowding of population in cities is tremendous and everywhere the daily struggle for enough rice to last till the next day consumes all the energy and interest of the average man. The burden of Confucianism puts a premium on male children who will keep alive the parents' memory in their ancestor worship. Early marriages and an unbelievably high birth-rate play an unmeasured part in the physical inferiority so common. In this connection, it remains to be seen if improved sanitation, and measures for health conservation and for decreasing infant mortality, will in China be attended by a substantial reduction in the birth-rate.

The fourth factor is the kind of leaders China can produce in a crisis such as the present. The specific form of government which may be established is of minor importance. The great thing is the character of the men who control it. As always, character is everything and the particularized form of expression of ideas and ideals on paper is incidental. This latter failing for redundant verbiage and the recording of noble and altruistic sentiments of government and private living which have no connection with the actual practice of such excellent precepts, is a characteristic weakness of the Chinese. This is illustrated by an extract from a decree of the late Empress Dowager, Tz' Ann, given at Sianfu on January 28, 1901, after the sacking of Peking and the court's flight to Shensi, following the collapse of the Boxer movement.

> The chief defect of our administration is undoubtedly too close an adherence to obsolete methods. The result is a surfeit of commonplace and inefficient officials, and a deplorable lack of men of real talent. Men of real ability are prevented from coming to the front by the mass of inefficiency which blocks the way. Our whole system of government has come to grief through corruption, and the first steps of progress in our empire are clogged by the fatal word "precedent." Up to the present the study of European methods has gone no further than a superficial knowledge of the language, literature and mechanical arts of the west, but it must be evident that these things are not the essentials upon which European civilization has been founded. China has hitherto been content to acquire the rudiments of European language or technicalities, while changing nothing of her ancient habits of inefficiency and deep-rooted corruption. Ignoring our real needs, we have so far taken from Europe nothing but externals.[3]

These words apply to China with equal force to-day. Whether there are in the present time of change and unrest the seeds of permanent change and a genuine desire for thorough domestic housecleaning, time only can tell. China lacks leaders, men with "purposeful will-power," not self-appointed, but produced by the national emergency, and prepared by a life conforming to the very principles of honor and patriotism which Chinese writers so delight to extol on paper.

The fifth factor is the present relation of China to foreign powers, considering not only China's real attitude and desire toward them, but

[3] Bland and Backhouse, "China under the Empress Dowager," pp. 422.

also her obligations to them and the demands they may require of her. Space forbids discussion of this factor at present. To quote once more from Bland, whose words have prophetic truth,

> The Manchus have joined the great company of kings in exile and the Chinese people are left once again to work out their political salvation. The difficulties which confront them are intensified by the fact that no longer, as in the periodical anti-dynastic rebellions of the past, can they hope to reestablish the normal order by the light of their own devices and instinctive traditions. The world is too much with them. For good or evil China can no longer be a law unto herself. She has given hostages to fortune in the shape of European loans. Now and henceforth her crises and her civil wars are become matters of concern to the world-family of nations, her disorganization and unrest a source of danger beyond her borders.

China is indeed but now becoming aware that her age-long isolation is ended, that, irrespective of her inclination, she must assume an active part in the social fabric of nations, and that the sure penalty of failure is disintegration.

To-day China needs leaders and can not find them. She needs money, men and brains, but the greatest need is for men of character. The opinion is too common that China can do in a decade what required centuries in Europe. But history presents few real novelties, and China will not be regenerated or rejuvenated in a single generation.

THE MALTHUSIAN DOCTRINE AND WAR

By EDWIN W. JAMES

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THE habitual pessimist is deservedly without honor even in his own country. The occasional, though deliberate, pessimist, however, may be forgiven his unhappy temper of mind because in the times we live in he provides a pleasing contrast to the garish hues of thought that prevail. Our thoughts, like our garments and our conduct, are all tinted with the gay lights of an irresponsible optimism that can well endure an occasional dash of somberness if not too violently applied. Certainly the attainder of pessimism attaches to any one who reverts to the Malthusian theory in these days of sociological light-heartedness. It was Carlyle who, impressed by the theory of population advanced by Malthus, characterized political economy as "that dismal science." Thus did Malthusianism appear pessimistic even to the arch-pessimist.

Malthus produced the second edition of his essay in 1803, five years after its original appearance; and this second edition is considered the most complete statement of his theory. Though the essay ran to at least five editions, no essentials were either altered or elaborated that had to do with his theory of population.

For many years English economists very generally gave the doctrine much place in their discussions, though its principles were not pleasant in their application and led many writers to attack not only the theory, but even Malthus himself. These attacks became very bitter in some instances, but were principally supported by sentimentalism and left the essential basis of the doctrine unscathed. The worst that can be said of it is that, as applied by Malthus and more especially by such writers as Say, it produced for the proletariat a gloomy outlook that appeared at the time incapable of being dispelled.

That the theory of Malthus has in later years come quite generally to be disregarded is true. But it had its day, when for upwards of a generation it constituted a theme of persistent discussion. It reached very general acceptance and finally declined in the notice of economists. Yet its decline was rather a gentle sinking into desuetude, because of the very general and remote effects of its operation, than an abandonment because disproof was furnished of its truth or power. We find Say, Bowen, Mill, Walker, Marshall, Laughlin, Fisher and more especially other English economists, accepting the doctrine as originally stated, but some make no mention of it, considering it perhaps as unimportant now.

The Malthusian doctrine shorn of its appurtenances declares the inharmonious relation between the increase of population and the increase of subsistence, and attempts to establish a compatible relation by demonstrating a system of positive and preventive checks ever active and effective in creating a balance between population and the ordinary means of subsistence. Malthus reasoned that population tends to increase in a geometrical ratio. The greatest probable value of the terms of the progression were assumed to be a first term of two, a rate of two and an interval of twenty-five years between terms. This assumes that each pair will produce two offspring in twenty-five years. Opposite this possibility is set that of the greatest reasonable increase in agricultural produce. The law of diminishing returns and observations of agricultural conditions led to the conclusion that the limit of increase of food stuffs is an arithmetical ratio. As land can not possibly be increased, the inharmonious condition potential in these two laws can only be adjusted by checking the increase of population. Two classes of checks were enumerated and called, respectively, positive and preventive checks. Among positive checks were death from malnutrition or actual starvation, death from the unsanitary conditions of poverty, and, in general terms, famine, pestilence and war. Preventive checks were of a uniform sort, appropriately grouped under the single term moral restraint. Since the post-Napoleonic period, the force of moral restraint has grown amazingly, until its effect in occidental countries has been practically to annul all action of the positive checks. It is doubtless this general fact that has relegated the Malthusian doctrine to the economic shelf. A hundred years ago the preventive checks were undoubtedly assigned a much smaller value than what they have since developed. Under these circumstances, Malthus's contention that, unless preventive checks were made effective, the positive checks would act, led to the reproaches that were hurled at the dismal Malthusian who predicted hopeless death from starvation, and made political economy the object of the scornful description of Carlyle.

Now, the present state of Europe offers a field for interesting reflection in the light of the Malthusian theory. There is no purpose in this paper to defend any one nation or to justify the conduct of any. Certainly, on this side of the ocean, the first feeling toward the present conflict among sensible men was one of deep disgust that civilized nations could not find a method of settling international questions without resort to arms. But obviously if a single nation insists on such a mode of settlement, it precipitates the cataclysm of war. Nevertheless, however sensible men may have felt, that some nation should have resorted to the arbitrament of arms is not without explanation in view of the potential tendencies involved in the doctrine of Malthus. This paper concerns itself with pointing out an interesting relation between

the theory of population as demonstrated by Malthus and war as practised in our times.

Now, it has been stated by an eminent American economist that economic laws should be considered rather as tendencies, but as tendencies that will certainly become realities unless some other economic tendencies are set up or artificial conditions created to resist them. Even then the original tendency is potential, and becomes active the instant the restraint is removed. If, therefore, mankind has found the effect of the Malthusian theory apparently negligible, it is because something has happened to prevent the action of the positive checks. For under this definition of an economic law we may include the positive checks of the Malthusian theory. If, therefore, they have remained practically inoperative since shortly after the time of Malthus, it is because the preventive checks have been strong enough to restrain them. On examination, we find such to be the case. The forces that are inclusively designated moral restraint have in France, among the upper classes in England, among the native born in New England and, indeed, among the great upper-middle class of Americans, been so active that the increase in the number of births relative to the number of deaths has been reduced to a very small figure.

This fact indicates a force of moral restraint appearing in late marriages and small families, that surpasses any conception held by Malthus or his immediate followers. Indeed, moral restraint has developed and become so essential a part of the *modus vivendi* of mankind that among the various checks submitted by Malthus it overshadows all others. Moreover, the reduction of increase of population has been not merely against a death rate continuing uniform, but against a constantly decreasing death rate. While moral restraint has been holding back the births from an undue excess over deaths, many forces have been acting to reduce the deaths per thousand of population. With the advance of the last century, western civilization has become strongly characterized by a spirit of consideration for the rights of all men to an equality of opportunity. This spirit has operated in many lines. It has practically destroyed human slavery; it furnishes penny meals to underfed school children. Along with moral restraint have gone these other ameliorating influences. But while that has tended to lessen the increase of population, these have tended to augment the increase. These influences are now considered vital elements in our civilization. They are chiefly embraced in medical and sanitary science and in eleemosynary institutions. For sixty years the western civilized world has struggled against nature to reduce the death rate, and the efforts have been attended with a marked degree of success. The discoveries of Lister and Pasteur have revolutionized medicine, the germ theory of disease gave a tremendous power of control over contagion and infection, thereby over

epidemics and pestilence. Preventive medicine has done much to eliminate some of the worst plagues that were visited upon mankind for generations. The great heart of the century we have left was opened to the crying needs of the poor. Fiske and Kidd have shown how altruism came to combat the mercilessness of the survival of the fittest, so that the strong help the weak. Eleemosynary bodies of various kinds assist the lower strata of the population, help them to meet the pressure of daily needs, and literally keep many alive.

Now, it is to be noticed that all these ameliorating influences constitute modifications of the positive checks of the Malthusian theory. Famine is being driven from the door of poverty by individual and legislative assistance, as well as by advances in agricultural science. Infant mortality is being reduced by public agencies acting through a large sanitary organization. Pestilence among western nations is almost a thing of the past. Doubtless these modifications of the positive checks have been possible only because of the tremendous force of moral restraint. Had this been so slight as to have permitted occasional action of the positive checks, it is probable that human life would have been on so low and difficult a plane that little would have been done toward modifying them. But the general opinions of man among the western nations are turned now toward better conditions of living, toward better sanitation. The public mind is open to the precepts of preventive medicine and various alleviating restraints are accepted as matters of common good. The state, as well as individual charities, is devoting much attention to the improvement of the condition of the economic poor—those who have little or no capital, or who have but a narrow margin between them and mere subsistence. By all these conditions and measures the Malthusian positive checks have been and are being modified, with one rather startling exception.

While the western nations have been alleviating famine and removing pestilence, they have at the same time by every conceivable device of science been increasing the destructiveness of war. Since the development of the ironclad and the invention of the breech-loading rifle, both products of the civil war in America, the progress of military and naval science has been greater than at any other time in the history of the world. In at least two of the great western nations compulsory military service has existed for many years; in several others large standing armies and powerful navies have been maintained in times of peace. While the public mind has been turned toward ameliorating the harshness of famine and pestilence, it has been accustomed to consider war as a possible contingency, not to be combated as undesirable, but to be prepared for. The peace propaganda is very, very modern. This attitude constitutes an important difference. The preparations against famine do not serve to make the famine worse, should it come. Nor do the pre-

ventive measures taken to combat disease lead to increased malignity in pestilence. But the preparations for war, whether considered in the light of preventives or causes of it, do serve to increase its intensity and destructiveness of life when it comes. Further, this difference has its subtle reflection in men's minds. Should any one advocate the cessation of all the modern sanitary, medical and eleemosynary measures for the alleviation of the condition of mankind, the individual attitude would be unhesitatingly against it. Men are now accustomed to the restraints placed upon their conduct by sanitary laws and regulations, to the uses of preventive medicine, to maintaining some advisable forms of poor relief, to public hospitals and to the multitude of altruistic elements that not only enter into our western civilization, but are now an integral part of it, essential to its continued existence. On the other hand, their minds are filled by custom and familiarity with a tacit acceptance of war. They have paid taxes for armaments all their tax-paying lives. They see the army units and the fleet. At the seaside resorts and along coast and inland waters they know where fortifications are located and their children play on the ramps and slopes. In many countries they have served in the regular army during two or three of the best years of their young manhood. Some have attended military schools, some have been in the yeomanry or the militia. The individual mind finds no shock in considering a resort to war.

Assuming, now, that an economic pressure develops, what is the obvious result? The assumption disposes of the preventive checks, moral restraint and agricultural progress. Both have at last been found wanting. The positive checks being potential, being economic tendencies, and, therefore, certain to become realities unless counteracted, begin to operate. But they have been so modified that only one—war—remains in force. Man's mind, all western civilization, is used to a system of altruistic alterations of some checks, also used to the idea of war. Obviously, the human mind will not revert to pestilence and famine. It will rather tolerate the alternative of which the idea has already been accepted.

Resort to arms, then, is the only positive check left to meet and adjust economic pressure according to the Malthusian theory.

Let us briefly summarize our contention to this point. The Malthusian positive checks are economic tendencies. Of these, all but war have been modified for the alleviation of human misery, and these modifications have become an essential part of our civilization. In case of economic pressure developing, mankind will not yield these essentials of his civilization, but will resort to a method of relief for which his mind is prepared. War offers such relief, as the only positive check left, and war, then, is not merely a possibility in case of economic pressure, but is of the nature of an economic certainty.

Exactly what would be considered sufficient economic pressure to induce resort to belligerent measures is not a determinable matter. Instances are obviously not numerous enough for any one or any one general group to be fixed upon as distinctively causative. It is possible that pressure might be imagined that did not really exist. It is quite possible that, led by influential persons or governmental agencies, the public might assume economic pressure imminent, though not actually existing, and might consider this assumption of impending pressure as a sufficient reason for a resort to arms.

It must not be understood that the weighing of these matters is deliberate and conscious. It is no more so than those notions that, reproduced in a multitude of human minds, make effective the law of supply and demand. Where, as in the case of war, action is taken through national agencies instead of being merely cumulative, leaders propose, take irretraceable steps, and the populace generally acquiesces. This is particularly the case if there has been a general prevalence of opinion favorable to such action. It must be constantly borne in mind that no economic law acts like a chemical or physical law. Human agents are the medium through which economic tendencies act. Without the human intermediary economic cause produces no economic effect. Inasmuch as the human element is composed of a great number of units, the strength of opinion in any one need not be great in order to make the effect marked. Indeed, the attitude of any one individual need be no more pronounced than that of the casual housewife, who when marketing decides in the most colorless and matter-of-fact way whether or not she will buy the attractive vegetables displayed at a certain price. And yet, it is the accumulation of such casual decisions that make operative the law of supply and demand with respect to a great mass of commodities. The necessary conditions are similar for a belligerent national attitude. Where, in addition to the cumulative effect of public opinion, there exist leaders capable of augmenting the apparent force of such opinion, who indeed may actually make it appear other than it really is, the chances of a very slight mental inclination on the part of the individual may, by its cumulative force, produce tremendous results. The effect of leadership on such slight individual opinion, when it contains any elements by virtue of which it can be organized or led, is seen in a small way in the effect of consumers' leagues and associations of women who have forced dealers in some of our larger cities to lower prices within a few hours on certain perishable commodities which were offered at unwarranted prices. So great is this cumulative effect, that the very slightest guidance of the most casual public opinion into a single economic channel produces a flood.

Obviously, there exists the greatest possible danger that this force of opinion will be misled, will be directed by demagogues into wrong

channels. This danger has always been recognized and is doubtless very real. It is certainly no less true that opinion properly led and directed will produce just as effective results as when diverted from its natural course or distorted from its natural form. Indeed, it might be reasonably supposed that such opinion would produce more effective and lasting results if properly guided, because it is then free from the impeding force that change of direction would involve.

It is not, therefore, necessary that some specific type or extent of economic pressure be discovered to establish the general truth of the connection between the Malthusian doctrine and modern war. That such pressure exists at any given time will be shown by the state of the individual mind in a degree no more pronounced than that state of mind which enables demand to act upon supply. It is only necessary that that state of the individual mind be sufficiently general to have a belligerent effect. The result will be war at the first opportunity; and the opportunity will probably be made.

That there should occur sufficient economic pressure to produce belligerent action is in no way out of harmony with the past effective operation of preventive checks. It is a fact that Malthus and his contemporaries for many years did not assign to moral restraint the great effect it developed in the last half of the nineteenth century. Nor did they allow for such advance in the agricultural arts as modern scientific farming has produced. These advances may well be associated with moral restraint in bringing about an adjustment between subsistence and increased population. One has caused the increase to be slower, the other has provided for subsistence for the increase beyond the point where the pressure of want would otherwise have been felt. The combined action of these forces has served to raise the numerical level of population and maintain it free from actual want. The effect has been to postpone action of the positive checks; but it can not properly be said to have destroyed them. As previously pointed out, the positive checks are to be accounted economic forces and as such are potentially active at all times. If restraining forces have raised the zone of economic pressure or altered its type, it has only been like raising the levees as the floods rise. The distance between gauge height and the top of the levee has remained constant, and the action necessary to produce pressure of a dangerous sort may be no greater to-day than it was a century ago. The powerful and sustained action of preventive checks over a long period has created an economic structure and maintained it in equilibrium at a much higher level than would otherwise have been possible. Should such preventive forces cease to act, for this very reason the collapse would be more violent. Population would at once be subject to accumulated pressure temporarily held in check. One can hardly imagine the effects should all moral restraint, all the improvements in

agricultural science during the last sixty years, be suddenly eliminated. Those earning but a living wage to-day, those having no, or only a slight, margin above mere subsistence, would face actual starvation within a single agricultural season. Within that time the cost of staple foods would rise to a point far beyond the reach of a great mass of the population of many countries.

It must be borne in mind, then, that preventive checks serve only to postpone the time of effective economic pressure. They do not eliminate it or even postpone it indefinitely. Like the levees referred to, raised against an encroaching stream, in time the ever increasing floods will rise above them unless they too are raised up higher. Any given set of preventive checks serves only for a period. Their effectiveness must increase *pari passu* with the increase of population permitted by them. If they fail to increase, they fail to continue preventive. The length of the period of restraint does not alter the principle, although it may obviously alter the method by which the principle will act if it is permitted to by the removal of restraints.

Although the degree of economic pressure is indeterminable that will produce a resort to arms, there appears no reason why the necessary pressure should not occur. Moreover, the economic field in which such pressure may arise is much more extended than in the days of Malthus. He supposed the pressure of subsistence to be the only one, or at least the most active one. But to-day we have several other directions in which pressure may more likely be developed.

For it is to be noted that modifications of the positive checks, tending to increase population, and the action of moral restraint, tending to decrease it, along with the advance of agricultural science, permitting some increase without additional pressure, have all operated together to raise the standard of living. This means nothing, unless it means that those things which were once luxuries have generally, in different measure among different groups of mankind, but throughout all contiguous groups existing at any given time, altered their classification and become necessaries of life. Once we pass from the merest elements of food and clothing, and from such a modicum of shelter as mankind can survive with, the line between what is a necessary for life and what a luxury becomes a matter of custom and habitude. The result of this elevation of the standard of living is to establish large groups of the population with an ample margin above mere subsistence, and to provide some margin for all groups existing at any given time, except that new group, provided for by the numerical increase of population, which is alike the newest and the lowest. This group may be assumed to exist only slightly above the margin of subsistence for at least a short time. A concomitant result of the change in the standard of living is to provide, in addition to the pressure of mere subsistence, a multitude of

points of contact between groups, or between nations, capable of responding to economic pressure. Communication is the necessary and sufficient element which at once unites nations and furnishes the numerous avenues along which this pressure may act.

These numerous points of contact may be assembled under a few simple heads; such as commercial, political, and the unequal distribution of world wealth. This latter may be called economic advantage or natural advantage.

If we assume any nation to be existing in such a status as to be free from all pressure, it follows that the industries of the nation as a whole enjoy unrestrained development and prosperity. For in such an assumption, no foreign competition could exist. Similarly, we may assume that pressure is such as to permit the unrestrained and unusual development of a few or even of a single industry or even of an exclusive phase of some large and important industry. Under these conditions, habits of living are acquired by the nation as a whole or the group within the nation, depending on the successful industries, which fixes more or less certainly its economic position with relation to other nations. Suppose now, that another group, as another nation, invades the particular commercial field so far as to produce pressure on the first group hitherto enjoying freedom from pressure. It is felt through the usual channels of competition. The depression of the industry affected does not bring the corresponding group face to face with famine. But it does tend to lower for them the standard of living. It brings pressure on their standard of comfort. This is just as truly economic pressure as that of want produced by lack of subsistence. If unresisted, its effects will not be so fatal; but man's disposition to remain passive under it is no greater than his willingness to accept hunger in even a slight degree. Indeed, man's disposition and powers are such that his actual resistance to such pressure will be greater than it would be were his strength only that predicated by mere existence on the verge of starvation. Being stronger, he resists more vigorously. The group concerned, then, having enjoyed certain privileges flowing from the elevated standard of living, are able to make their cry heard. Were this group on the edge of mere subsistence, though economic pressure would then be absolutely a more serious matter, they would probably have neither the ambition, the means nor the time, in their struggle for mere existence, to make themselves heard.

Thus it is that those newly exposed points of contact, classified as commercial, may produce much greater results with much less pressure than would at first thought be expected. When the groups are nations, as suggested above, then the commercial pressure is a matter of considerable moment to some more or less small class of leaders. These, by association of interests, can use their influence to exaggerate the

actual pressure until it is made to appear as an impending national calamity. How great such influence can really become within any nation may be seen in the tariff history of the United States. If this pressure becomes sufficient, or can be made to appear sufficient, the leaders can act, take irretraceable steps, and the public is very likely to acquiesce. This sets into operation the only remaining positive check in hopes that the pressure will be removed.

Then, there may arise conditions in which the points of contact between nations, capable of responding to pressure, may be classified as political. Such pressure was felt and strongly developed during the French Revolution and during the decade centered about 1848. Europe arose against the French Revolutionists because Monarchy feared the pressure of Republicanism. The disturbances all over Europe during 1848 can be traced directly to the pressure produced on Absolutism by Republicanism. This form of pressure, as it obviously lends itself to exaggeration and distortion more completely than any other, is the most difficult to isolate and free from accessory and complicating conditions; but it appears most probable that such pressure or seeming pressure was made use of to provide cause for the existing conflict in Europe.

The decline of the absolute power of western monarchs has not served to remove possibility of pressure on the political points of contact among nations, so long as the monarchical institution is maintained with stratifications among the population. The "king's friends," the monarchical party or class, will always remain most sensitive to such politico-economic pressure, both actual and mediate. Being, too, of great influence, these individuals are strongly inclined to exaggerate the pressure for their own ends. The position, the influence, the advantages of certain privileges accorded to artificial rank, the emoluments and sometimes the estates of such persons are held subject largely to the continued existence of monarchy. The positive check of war, expected to remove the pressure, is brought into operation quite easily so far as this class is concerned, for individually their opinions are more generally and more strongly inclined toward war than those of any other class. With them it is largely a matter of tradition, a survival of feudalism, a tattered remnant of chivalry. It remains only to impress the fact and the degree of such pressure upon the other classes of the nation. The monarchical tradition has always been strong among the nations of the world until actual collapse of the kingly power has come, so such necessary impression is more easily conveyed than might be supposed. This arises also from the fact that the control of the governmental machinery, of the entire national regime, is almost wholly in the hands of the monarchical element wherever it exists.

Finally, there is a third series of points on which nations come into contact capable of transmitting economic pressure. These points are

established by natural advantages, or other causes producing an unequal distribution of world wealth. The fortunate geographical position of one nation gives it advantages, such as reside in sea-ports, in fertile plains, in navigable rivers, that another nation may not possess. Again great mineral wealth and other natural resources of tremendous value may accrue to one nation by the merest chance of locality. Obviously such natural vantages give the possessor a stronger economic position than that of another nation less fortunately supplied. This unequal distribution of the wealth of the world may develop an economic pressure. The less fortunate nations have to strive harder to create compensating advantages by industry, thrift and self-denial. As these virtues remain ever necessary, and serve only temporarily to decrease the gap created by unequal distribution in a large way of worldly advantages, the impelling force, acting on the nation, to produce bodily comforts, ease and wealth assumes at last the aspect of economic pressure. The nation labors under a natural disadvantage. If other nations labor equally, the natural disadvantage is never overcome and the gap, though perhaps never widening, remains and perpetually represents an enormous quantity of wealth, and its accompanying ease and enjoyment, that is denied to the nation by mere chance. This, at least, is how it appears to the minds of the group so affected. We hear it said, for instance, that they want "a place in the sun." War then plays the rôle indicated for it, and resort is had to war in the hope that the pressure of disadvantages will be removed by the fortunes of war.

It is of course possible that a combination of these various forms of economic pressure, together with that of subsistence, may arise. The last two forms are particularly likely to occur in juxtaposition, and it would seem, for reasons already cited, that a monarchical party could be particularly successful in augmenting the sense of pressure which flows from the unequal distribution of worldly advantages. Such appears to have been the case in the present war.

Summarizing again, we find that the degree of economic pressure to produce a resort to war is not determinable. This fact does not alter the status of war as the only effective positive check remaining. The germ of economic pressure resides in the public state of mind and need not be strong in any individual. That such pressure exists is not inharmonious with the past action of preventive checks. There are forms of economic pressure other than that of subsistence, possible and probable under the conditions of modern civilization. Pressure may have a commercial or a political basis or may rest on an unequal distribution of natural advantages. In any case of economic pressure the public mind is prepared by custom, teaching and general familiarity, to accept war as the only possible check. War, then, tends to follow not only the pressure of population on subsistence, but also pressure on the standard

of living flowing from commercial causes, pressure on the type and stability of government flowing from foreign political conditions, and pressure on the general mode and circumstances of the national regimen flowing from an unequal distribution of the natural advantages of the world.

The contention thus developed leaves us in much the position that might be expected to result from any reversion to the Malthusian doctrine. Pessimism is of the essence of the conclusion. And, yet, as in the case of the earlier Malthusian developments, the conditions may not be so hopeless as they at first appear. Just as an unexpected opposition to the free activities of the original Malthusian positive checks was found in moral restraint, so a relief from an inevitable belligerency among the nations of the world may be found in an enlightened attitude toward international relations. A mere propaganda in favor of peace will not suffice. This would doubtless serve to alter the opinions of some, perhaps of many, but it must make its way constantly against the established opinion of mankind and in direct opposition to definite economic tendencies. To secure itself, therefore, in a position of strength and influence, such a propaganda must not confine itself to the advocacy of peace for the sake of peace, because as matters stand now war may be made for the sake of better things than peace in the mind of the world. It must aim directly and intelligently at removing the causes of possible pressure. Government must make lawful the dissemination of knowledge of contraceptives to assist moral restraint, agricultural science and rural development must be advanced and improved. Rural life must be made attractive. Free trade among all nations must be furthered. Every possible hindrance to trade must be removed, tariff and trade wars must be entirely abandoned and nations must be taught to develop their own peculiar advantages if any exist, and exchange the products through the customary channels of international trade for the products of unusual advantages possessed by other nations. Republican government must be made more efficient and absolutism in all its ramifications discredited and finally abolished all over the world.

Unless such results flow from a peace propaganda, it is effort wasted. Only in the degree that these conditions obtain will the possibilities of war be removed, and until the causes of economic pressure are eliminated or equivalently controlled, belligerency remains a potential economic force, for which men's minds are prepared; one without existing alternative, ever impending, ready to become active as the result of indeterminable, but probably slight economic pressure.

ON THE REPRESENTATION OF LARGE NUMBERS AND INFINITE PROCESSES

By Professor ARNOLD EMCH

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IN a popular sense large numbers often cause amazement, or command respect and arouse curiosity. Sometimes, when occurring in problems of chance, they assure practical certainty, or reveal the law according to which an event may be repeated. From extremely large numbers we may pass to infinite numbers by defining these as numbers that are larger than any finite numbers. Although infinite numbers are no proper numbers at all and can not be explicitly represented or conceived, it is in many cases possible to state or establish the law of their formation, and to use them in the deduction of important results. In fact, they are of the greatest importance from a mathematical standpoint. The same is true of infinitely small numbers, the reciprocals of the infinitely large. Very small causes may have tremendous effects. But it is nevertheless true that, while theoretically the infinitely small is just as important as the infinitely large, it is the colossal, the enormity of a number, of a quantity, of a magnitude that appeals to the popular imagination. The distance of a thousand light years which light travels in a thousand years is, for example, of such a character. All astronomical distances, no matter how large, as long as they are defined by a finite number of light years, are finite and can be expressed by a finite number of miles. The infinitely small and large, on the other hand, are antinomies which can be approached through indefinitely increasing and decreasing finite numbers only; they are concepts which are imposed upon the human mind (Zwangsvorstellung) in the form of postulates. Throughout the history of human thought attempts have been made to explain the mystery of the infinite. In ancient times, sophistic and mystic methods, partly connected with the supernatural, were ordinarily followed to explain the secret. The well-known problem of Zeno is a typical example of the reasoning that was applied in case of an infinite process. The Eleat Zeno (born about 500 B.C.) contended that such things as multiplicity and motion were impossible. To prove that there can be no motion, Zeno devises the problem of Achilleus. In a race between the fast runner Achilleus and the slow moving tortoise, the latter can never be reached by Achilleus, because the pursuer must always first reach the point where the pursued was. During this time-interval, the tortoise gains headway and

reaches a point ahead of the pursuer. Thus, during each successive time-interval the tortoise moves some distance ahead of Achilleus, and as the number of intervals increases indefinitely, the race can never end. This, according to Zeno, proves the non-reality of motion. The sophistry of this reasoning is, of course, apparent, although there are some modern logicians who are inclined to side with Zeno.

Even much later as great a philosopher and mathematician as Leibniz (1646–1716) mixed up metaphysical speculations with the discussion of mathematical infinity. Leibniz discovered the diadic system, according to which every number may be represented by a definite succession of the two ciphers 0 and 1 only. He identified $1 = $ unity with God and 0 with nothing. God created all things out of nothing, just as all integral numbers may be formed by the ciphers 0 and 1 in the diadic system. Leibniz was so enthusiastic over this seemingly remarkable discovery that he asked the Jesuite Grimaldi, at that time president of the mathematical tribunal of China, to communicate the discovery to the Emperor of China, who had the reputation of being a friend and patron of science. Leibniz hoped that in this manner the Chinese Emperor might be won over to Christianity.[1]

In a letter[2] to Christian Wolff, Leibniz discusses the infinite series

$$1 + x + x^2 + x^3 + \cdots,$$

which is obtained by dividing unity by $1 - x$. When x is less than 1, there is no trouble, the value of the series is equal to that of the quotient $1/1 - x$. For $x = -1$ the value of the quotient is $\frac{1}{2}$, while the series assumes the form

$$1 - 1 + 1 - 1 + 1 - 1 + \cdots \text{ad infinitum.}$$

In this case, the infinite process in forming the series is devoid of any meaning; the whole argument breaks down. This is not what Leibniz and other contemporaries thought. He reasoned as follows: The series is infinite; when we take an even number of terms their sum is zero; for an odd number the sum is unity. Now, as we can not distinguish between an even and an odd infinite number of terms, the total number can be neither even nor odd, and the sum of all terms can therefore be obtained in the most natural manner by taking the average of the two values 0 and 1. This, according to Leibniz, gives the sum of $\frac{1}{2}$ for the infinite series. Leibniz refers to another Italian Jesuite, Grandi, who saw in this example the proof of creation as revealed in the Scriptures. Adding the terms of the series in groups of two, $(1 - 1) + (1 - 1) + (1 - 1) + \cdots$, we get

$$0 + 0 + 0 + \cdots \text{ad infinitum} = 1/2,$$

[1] La Place, "Théorie analytique des probabilités," Oeuvres, Vol. VII., pp. cxviii–cxix (1812).

[2] "Leibnizens mathematische Schriften," Erste Abteilung, Band IV., pp. 382–387 (Halle, 1850).

which, according to Grandi, proves the divine power to create something out of nothing. Laplace, commenting upon the fallacy of Leibniz' arguments, shows that there is nothing particular in the foregoing series, since the expansion of the quotient $(1+x)/(1+x+x^2)$ gives the same series, while its value for $x=1$ is two thirds.

The controversies on the infinite have lasted to the present day. It must be admitted, however, that they have assumed in most cases a very refined and exquisitely subtile form. In certain respects the difficulties have increased, and arguments in the style of Leibniz and his contemporaries appear as infantile efforts of a vanished period. The logicians have come to discuss the possibility of such concepts as "the class of all classes" and other artificial difficulties. Sometimes it would seem that the modern logicians are again occupying the stage vacated by the Greek school of Sophists centuries ago. It can not be said that they have come nearer the solution of the riddles of the universe.

Probably the greatest advance in the concept of infinity has been made by the definition that an aggregate of elements is infinite when the number of elements of a part of the aggregate is the same as the number of all elements of the aggregate. A popular expression for this definition may be put in the form: Infinity has the property that a part is equal to the whole. Consider, for example, the series of all positive integers and multiply each by two, then we obtain a second series of integers that contains exactly as many integers as the first series:

1	2	3	4	5	....
2	4	6	8	10	....

The second series, however, is evidently contained in the first. The same definition applies to continuous sets of points which after the method of Dedekind may be put into one-to-one correspondence with a continuous set of real numbers. Let AB, Fig. 1, be a segment of a straight line and consider the infinite number of all points of this segment, including A and B. From a point S project the points of AB upon the segment CD, so that in this correspondence there are as many points on CD as there are on AB. From another point T, we can project the points of CD upon the seg-

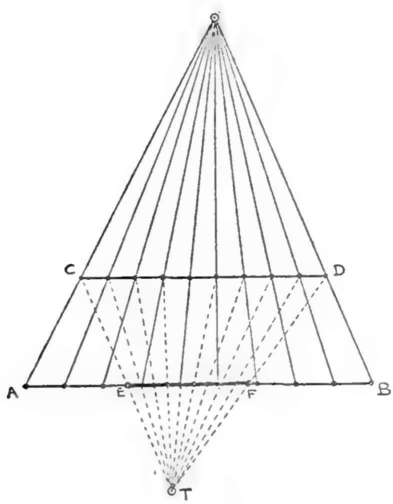


Fig. 1

ment EF which lies on the same straight line as AB, such that AB contains EF as a part. Now there are as many points on EF as on CD in the projective correspondence, and consequently as many as on AB. In other words, the number of points on AB is the same as the number of a part of AB.

Pure logic, detached entirely from intuition, is impotent in the treatment of such problems. It is not only sterile, but engenders new antinomies.[3]

As has been stated before, there is no difficulty in the investigation of large numbers as long as they remain finite. Although the answers to problems which involve very large finite numbers may be amazing, they are definite and, at least theoretically, may be made intelligible through proper representation. It is evident that in concrete form a large number does not necessarily have to be connected with large spatial dimensions. Thus, in the relatively small space of one cubic centimeter of air under standard conditions, there are thirty million million millions of molecules. On the other hand, the distance of the nearest star (α centauri) is four and three tenths light years, or about twenty-five million million miles. There are telescopic stars whose distances are measured by thousands of light years. Light travels 186,330 miles a second and it would take the light of those stars thousands of years to reach the earth. To the scientific mind the revelations of astronomy are not more wonderful than those of the ultramicroscopic world. As an example we mention the remarkable molecular structure of crystals, as shown by Professor von Laue, who recently received the Nobel prize in physics for his discoveries. The wonderful geometric lattice-work formed by millions of molecules per cubic millimeter is revealed on the photographic plate by the diffraction of Röntgen rays on the molecules. Here we have the counterpart of the extremely large. The wave-length of Röntgen rays is so extremely small that they are diffracted by the extremely small molecules of the crystal. These may be considered as extremely small models of solar systems in which the electrons take the place of planets and other heavenly bodies.

Just as it is convenient to make use of auxiliary units like the astronomical unit (distance of sun from earth $=$ 93 million miles) and the stellar unit (light year), great numbers in entirely different domains may be made more intelligible by concrete representation. Take, for example, the arithmetical expression 9^{9^9} which means nine raised to a power whose exponent is nine raised to the ninth power. The number thus obtained is certainly finite, although its explicit representation would be well-nigh an impossible task. For practical purposes, and in

[3] Poincaré, "Science et Méthode," pp. 210–214 (1908). See also "Les étapes de la philosophie mathématique," by Léon Brunschweig, pp. 370–393 (1912), where an excellent discussion of the logistic philosophy of mathematics is given.

the language of the layman, we might call this number infinite. It has 369 millions 690,000 places. To write it down, reserving one fourth of an inch for each cipher, it would take a strip of paper that would reach from Phoenix, Arizona, to New York City. Compared with this, the number of atoms in the Atlantic ocean would be negligibly small, and the Hindu fabulist with his story of a battle of a sextillion (unity with 36 ciphers annexed) monkeys would not strain our imagination as to largeness.

Large numbers, relatively small in comparison with those given above, are of great practical value in the theory of probabilities and statistics. By mathematical probability of an event we understand the ratio between the number of cases of actual occurrences and the total number of possible cases of the event. The greater the number of actual occurrences out of the total number, the larger the probability of such an event. When the two numbers are equal then the probability is equal to unity, in other words, the probable event becomes certain. A larger number of repetitions of a certain type of events contributes to our judgment of certainty. This fact has been stated by Poisson as "the law of large numbers," and may be expressed more definitely as follows: If p (a proper fraction) is the constant probability of an event and if the conditions for this event are repeated s times, whereby it occurs actually m times, then, by repeating the conditions a sufficiently large number of times, the difference between p and s/m can be made as small as we please. Thus, the probability that in the game of throwing a coin, head will appear is one half. Buffon, who once had the patience to do this 4,040 times, obtained 2,048 times head, so that the difference $p - s/m$ is in this case -0.007. If Buffon had repeated the experiment a million times the difference would be very much smaller. The fact that during the last 6,000 years, days and nights have followed each other without a break over two million times makes it certain that the sun will rise in a clear sky or behind a cloud to-morrow. From the standpoint of mathematical probability and large numbers there is nothing extraordinary in two million confirmations of an event. And yet, in every-day life, such numbers in the realm of chance mean certainty to us. Mathematically speaking, we are satisfied with very crude approximations in this world. We never use anything else in practical life than comparatively very simple rational numbers. For $\pi = 3.1415926 \ldots$, with an infinite number of ciphers, we never can use anything else than a rational approximation. Although the ten thousandth place of this transcendental number is an absolutely definite cipher between 0 and 9 (inclusive) we do not know what it is and it is a physically impossible task to determine it. We live in a domain of relatively small rational numbers and are satisfied with crude approximations where absolute accuracy can not be obtained.

Pure mathematical reasoning has nothing to do with the world of approximations. The number π has an absolutely definite meaning and exists. Likewise the incredibly large number defined as nine raised to the power (nine to the ninth power) is absolutely definite and finite in spite of the explosive character of its increase. The infinite series

$$\tfrac{1}{2} + \tfrac{1}{3} + \tfrac{1}{4} + \tfrac{1}{5} + \cdots \text{ad infinitum}$$

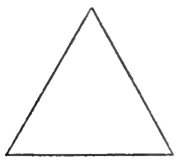
for which the sum of an increasing finite number of terms creeps along with unbelievable slowness, is divergent, *i. e.,* it has an infinite value. Indeed, when we add its terms successively in groups of one, two, four, eight, etc., we obtain an infinite number of such groups whose values are all larger than $\frac{1}{2}$, so that the value of the series itself is infinite. The problem shows an entirely different face when we attempt to actually add up the fractions in order to see how they contribute to the infinite value of the series. From the standpoint of the computer the legitimate mathematical claim for divergency of the series appears as a ridiculous pretense. Let us, for curiosity, figure out how many consecutive fractions of the series one must add to each other in order that their sum will amount to 100. Suppose that it is possible to write these fractions upon a strip of paper one half inch wide so that a cipher is reckoned for every half inch of length. With this strip the whole universe for which we assume a diameter of about 20,000 light years could be completely wrapped up and covered to a thickness of hundreds of miles. Millions of tons of ordinary writing paper would be necessary to manufacture such a strip of paper. This much is necessary to make a contribution of about one hundred units to the infinite account claimed by impeccable mathematical logic. In spite of practical impossibilities of this kind, there is of course no sound reason to dispute or criticize the rigorous conclusions of science as has been done in a very clever essay by Alexander Moszkowsky in "Zukunft."[4]

In conclusion, I shall briefly discuss a geometrical example involving an infinite process with a perfectly definite result. A complete geometrical representation of the process is impossible. But this is not more remarkable than the impossibility of making a visible representation of an actual mathematical point, or of a circle. In ancient times the possibility of a tangent was always connected with the idea of a continuous curve. Since the classic discovery of Weierstrass of continuous functions without derivatives, that idea had to be completely abandoned. As Peano and others have done, it is easy to state perfectly definite laws for the construction of continuous curves that admit of no definite tangents. To construct such a curve consider, for example, an equilateral triangle whose sides are equal to the unit of length, Fig. 2. Divide each side into three equal parts, remove the middle parts and

[4] "Das Geheimniss der grossen Zahl," Vol. 78, pp. 85–94 (1912).

bridge the gap over by two adjacent pieces, each of one third the length of the original side. In this manner a new Fig. 3 is obtained whose circumference is evidently four thirds of the original length of three units. We now repeat the same operation on each of the twelve segments of the new figure and thus obtain Fig. 4, whose circumference is four thirds of that of Fig. 3, *i. e.*, $(\frac{4}{3})^2 \cdot 3$. We repeat this process a third (Fig. 5), fourth time, and so forth, *ad infinitum*. The circumference of each new figure is always four thirds of that of the previous figure. Repeating the process n times, we obtain a crinkly curve with the length $(\frac{4}{3})^n \cdot 3$. When we let n approach infinity, the figure approaches a perfectly definite continuous curve of finite dimensions, but of infinite length, since the nth power of $\frac{4}{3}$ increases indefinitely as n increases indefinitely. This curve defined by a very simple geometric law is a so-called Jordan-curve and has H. v. Koch and Cesaro as its originators.[5] A complete geometric construction of this curve, involving the configuration of the limit, is impossible.

FIG. 2



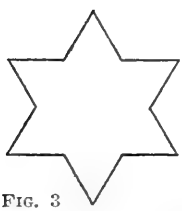


FIG. 3

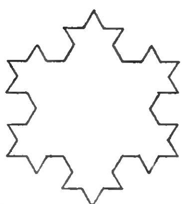


FIG. 4

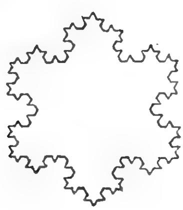


FIG. 5

As is shown by this and other examples, we can conceive in a perfectly definite mathematical sense infinite processes which do not admit of complete explicit representation. This, however, is not more remarkable than the impossibility of representing explicitly all elements of certain extremely large finite and transcendental numbers.

Insurmountable difficulties only appear when we try to grasp problems involving the infinite by introducing peculiar logistic postulates. Then paradoxes and antinomies become supreme.

[5] E. Study, "Konforme Abbildungen," pp. 42–43 (1913).

THE ENERGY CONTENT OF THE DIET[1]

PROTEINS IN GROWTH

By RUTH WHEELER
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An eminent biochemist said recently to a friend of mine: "The time is coming when you will give a grocery order in this fashion: 'Send to 3405 South Street 1,500 calories of eatables, $\frac{1}{4}$ protein and the rest half carbohydrate and half fat, the whole to cost fifty cents.'" It seems to put considerable responsibility on the grocer. One wonders if the time may not come when a doctor will say to a dietitian, "Plan a two weeks' dietary for that sick boy in room 101 in which the protein shall contain 2 per cent. trytophan, 5 per cent. tyrosin, 15 per cent. glycocoll," etc. The rôle of proteins in growth is fast becoming the rôle of amino acids and a difficult time is ahead of the dietitian. The accumulation of facts fills full the lives of one group of people; gathering and correlating the facts as they accumulate is enough to fill the lives of another group; and the practical application is far more than enough for another group. The groups are not in sufficiently close contact.

The body uses amino acids, but it must be fed proteins, and the amino acids it receives depend in amount at least not only upon the chemical composition of the protein, but upon its physical character and upon the other substances combined or mixed with it in the food. There has long been evidence that the proportion of ingested protein that is digested and absorbed from bread varies with the amount of grain cortex present, less being absorbed from the coarser varieties; that it varies in other foods with the amount of cellulose present. The much-discussed inadequacy of corn to serve as an exclusive ration, long thought to be due to the character of its proteins, has been shown by Hart and McCollum[2] to lie in its mineral content. When this is corrected, normal growth is possible on a corn ration. This, of course, is rather a misinterpretation than an actual modification of the utilization of the protein. Similarly, the apparent inability of some babies to utilize milk proteins is not unfrequently due to an excess of fat or of carbohydrate in the food. When this is remedied, the symptoms of protein indigestion disappear. We have found recently that the digestion of milk proteins is distinctly and

[1] Papers presented at the symposium before the Section of Physiology and Experimental Medicine of the American Association for the Advancement of Science, Columbus, December, 1915.

[2] "The Influence on Growth of Rations Restricted to the Corn or Wheat Grain," *J. Biol. Chem.*, 19, 373–97, 1914.

differently modified by the various carbohydrates commonly used in milk modification for babies.

In order, then, to consider the rôle of proteins in growth from the standpoint of the sources of our food supply, it is necessary to consider (1) the utilization of proteins, dependent on those characteristics of the proteins themselves or of the foods containing them, which make them resistant or not to the digestive enzymes or which influence the rate of their passage through the alimentary tract; (2) their assimilation; to what extent they can supply the essential amino acids in the proportion in which the body can use them for tissue building; and (3) the physiological effect of individual amino acids, especially, perhaps, those furnished by the proteins in question in excess of the body's needs.

The experiments of Mendel and Fine,[2] and more recently a shorter series by Howe and Hawk,[3] show that when fed in a more or less isolated form, the proteins of cereals are as completely digested and absorbed as are the proteins of meat—91–97 per cent.; but for the proteins fed in the natural foods these values do not hold. Only 80–85 per cent. of the nitrogen of wheat bread is absorbed, 70 per cent. of rye, 58 per cent. pumpernickel, 40.76 per cent. barley and 61–82 per cent. of corn nitrogen. These values for the whole grains were determined a good while ago by methods less accurate than those now in use, but they are at least comparable among themselves and they show, undoubtedly, lower protein utilization in grains than in isolated grain proteins.

This loss must be considered in planning the dietaries of young children, especially of those who can not take much milk. The proteins of cereals are as well utilized as milk proteins if they are fed in isolated form, but as long as dietaries contain not gliadin and glutenin and maize glutelin, but cream of wheat and hominy, we must count on a loss of 20–40 per cent. of the protein, if the data at present available represent facts. The proportion of the protein intake that comes from cereals is far from negligible in many children's dietaries, and it is unwise to get too close to the minimum protein requirements, especially as we do not know exactly what this minimum is. Hindhede's[4] surprisingly successful maintenance of body weight and good nutritive condition on an exclusive diet of potatoes and fat would indicate a high utilization of potato proteins.

With equal digestion and absorption, proteins may still differ greatly in their suitability for tissue construction and otherwise in their physiological effect. It has been found that 20 per cent. of the nitrogen absorbed from ingested zein is promptly excreted in the urine; over 40 per

[2] "Utilization of the Proteins of Wheat," *J. Biol. Chem.*, 10, 303, 1912; "of Barley," *ibid.*, p. 339; "of Corn," *ibid.*, p. 345.

[3] "Utilization of Individual Proteins as Influenced by Repeated Fasting," Eighth International Congress of Applied Chemistry, 19, 145.

[4] "Studies on the Protein Minimum," *Skand. Arch. Physiol.*, 30, 97–182.

cent. of gelatin nitrogen. Howe and Hawk found that the proteins of meat and of the commercial wheat preparation gliadin are equally well digested and absorbed, but when fed five days in equal quantity and in similar rations, gliadin gave a negative nitrogen balance of 1.3 g., while meat gave a positive balance of 11.3 g. A large number of proteins have been shown by Osborne and Mendel and others to contain all the amino acids necessary for growth: ovo-albumin, ovo-vitellin glutenin, maize glutelin, edestin, casein, lactalbumin.

Several natural mixtures of proteins such as those occurring in wheat, corn, oats, milk, respectively, have been studied, largely by Hart, McCollum[5] and their co-workers, and have been found to furnish the amino acids necessary for tissue construction. McCollum[6] has compared the protein mixtures in these grains with one another and with the protein mixture of milk as to their availability for growth. Of the nitrogen of cereals 23–24 per cent. is available, 45 per cent. casein nitrogen and 63 per cent. of milk protein nitrogen fed as milk. Evidently, the amino acids resulting from the digestion of milk proteins not only contain all the units necessary for tissue building, but contain them more nearly in the proportion in which they can be used than is the case with the other foods considered. If there is a shortage of one amino acid essential to the building of a body protein, the amount of that acid present determines not only the amount of tissue construction, the rate of growth, but determines also the proportion of the food protein that can be used for growth. The body can store very little reserve amino acid—nearly all that can not be built into protein is promptly deaminized and the nitrogen excreted.

These facts are also shown in a different way in recent experiments of Osborne and Mendel.[7] The growth of rats on 18 per cent. casein food was normal, on 12 per cent. casein food subnormal, but the addition of a small amount of cystin to the latter ration made it equal to the 18-per-cent. casein food in growth production. The utilization of the whole protein for growth was increased by an increase in the amount of the needed unit. Similar results were obtained by adding lysin to edestin.

These and similar investigations have thrown light on the nutritive value of individual amino acids: the aromatic amino acids are essential to maintenance; cystin, lysin, probably arginin and histidine, are essential to growth. Evvard suggests that cystin may be responsible for the darker and thicker hair of pigs whose mothers received rations rich in cystin during pregnancy; Lusk[8] in his study of the specific dynamic

[5] "Influence on Growth of Rations Restricted to the Corn or Wheat Grain," *J. Biol. Chem.*, 19, 373–97, 1914.

[6] "Value of the Cereal Grains and of Milk for Growth," *ibid.*, p. 323–35.

[7] "Comparative Nutritive Value of Certain Proteins in Growth," *J. Biol. Chem.*, 20, 351–78, 1915.

[8] "Investigation into the Specific Dynamic Action of the Foodstuffs," *J. Biol. Chem.*, 20, 555–618, 1915.

action of food stuffs, finds that glycocoll has a specific dynamic action of 100, alanin of 50.

Many of these results of nutrition studies can not be used with confidence in problems of human nutrition until more is known about the differences in the amino acid content of the flesh of different species. The pig can use 23 per cent. of wheat proteins for growth, but we can not yet be sure that this is true of the child; and so of many of the other very interesting and valuable contributions cited. They suggest wonderful possibilities—future possibilities—for the dietitian: a child who is undersized and frail can sometime be fed just the right combination of milk, eggs and cereals to furnish the amino acids he needs in the right proportion with no large excess of any one to overtax the excretory system or to overstimulate metabolism; a worn-out neurasthenic can be given just the right amino acids to replace worn-out tissue and enough glycocoll to stimulate metabolism—in gelatin perhaps. We have some slight clinical evidence that this last works out.

THE MINERAL NUTRIENTS IN PRACTICAL HUMAN DIETETICS

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IN consenting to present this paper I did so with the feeling that perhaps I have as good right as any one else to confess for all of us that we know very little about the subject. The suggestions I have to make then are offered in entire humility and with satisfaction only that we are on the road to more complete understanding.

My task is to point out the bearings of results of experiments in the field of mineral metabolism upon our irrational, uncontrolled and largely uncontrollable human dietetic affairs. Only in the case of infants, invalids, lunatics and convicts does it seem practicable to regulate the diet of human beings with the same rationality and particularity with which the successful live-stock farmer habitually feeds his animals. In spite of the difficulties of the task, however, and the indifference of most of us to the economic and rational aspects of our own eating, there are those dependent upon us who should have the benefit of our wisest counsel, even though we put ourselves in the position of saying, "you are to do not as I do but as I say."

In order to bring clearly to mind the basic principles of nutrition involved in this consideration I must enumerate the functions of the mineral elements in animal metabolism:

As bearers of electricity the mineral elements dominate the whole course of metabolism.

They conduct nerve stimuli, and play a leading rôle in the general process of cell stimulation.

They govern the contraction of the muscles, including those of the heart.

They compose the central agency for the maintenance of neutrality in the blood.

They enter into the composition of every living cell.

They compose supporting structures.

They assist in the coordination of the digestive processes.

They activate enzymes, and through their control of the chemical reaction of the blood and tissues they govern enzyme action.

They unite with injurious products of metabolism, and render them harmless or useful.

As catalyzers they alter the speed of reactions, and the rate of metabolism generally, as measured by oxygen consumption.

Through their effects on osmotic pressure they govern the movement of liquids, and maintain the proper liquid contents of the tissues.

Through their effects on surface tension they participate in the mechanism of cell movement.

Through their control of the imbibition of water by the colloids they govern absorption and secretion.

Through their control of the affinity of the blood for gases they govern respiration.

Finally, they control the state of solution, precipitation, mechanical aggregation, chemical association and ionization of the colloids which compose living tissue.

These then are some of the functions of the mineral elements. Considering their nature and importance, it is at once obvious that life could not endure if its complex mineral requirements were not automatically and constantly maintained in almost perfect adjustment. What then are the facts which warrant the practical consideration of this subject? They are that in pathological states these functions are somewhat deranged, and that life as we live it is in many respects highly abnormal, in the sense of differing from that to which human metabolism is attuned; and with our ever-increasing social differentiation life puts increasing stress upon the integrity of the body and its normal processes. In relation to food materials there are also important facts bearing on this matter of the mineral nutrients, for while highly developed processes of food manufacture and efficient world-wide transportation give us the greatest opportunities for correct dietetics that there has ever been, these same agencies open the way to greater unwisdom and abuse in dietetics than have been possible in our more primitive days. The net result is an obligation on our part to prepare a defense of knowledge against the misfortunes of prosperity.

It is my belief that anything like exact quantitative control of human mineral metabolism, as a practical measure, is as impossible as it is unnecessary; impossible first, because any kind of control of human dietetics is very difficult; second, because our knowledge of the optimum mineral requirements of human beings is especially slight and fragmentary; third, because the interactions of the mineral elements among themselves affect mineral metabolism in such prominent ways that fixed and definite statements of mineral requirements are quite apt to be misleading. And exact control in these matters is unnecessary because of the existence of safety provisions, for bridging over temporary deficiencies, of a perfection in harmony with the surpassing importance of mineral metabolism.

It is my belief, therefore, that in our present state of knowledge close statements of the mineral requirements of human beings involve a large element of "ceremonious delusion" (borrowing the expression from Thudichum), and that practical advice regarding the mineral metabolism of healthy human beings may most properly be general in character, and in the nature of recommendations of *types* of food products which should predominate in the diet under the various conditions of life, growth and activity.

We shall discuss certain of the mineral nutrients in detail, citing facts as to their occurrence in foods and metabolism in the body.

The one mineral salt which we use as such—sodium chloride—occupies a unique position among the mineral nutrients. Within wide limits it seems to make little difference how much sodium chloride we consume, and the kidneys excrete this salt without marked energy expenditure. Under certain conditions excessive intake of this salt causes slight increase in nitrogenous outgo, but such abnormal consumption would result in indigestion before the increased protein katabolism would become important in extent.

A special method and capacity of the kidneys for the elimination of sodium chloride is shown by observations of Schloss[1] and of Borchardt.[2] It appears that this salt alone fails to cause a loss of water from the body corresponding to the amount of salt eliminated.

Bunge relates our unusual appetite for salt to the potassium content of the diet, and the antagonistic relation between sodium and potassium which exists in metabolism. It takes such a quantity of potassium salt to cause an appreciable increase in the elimination of sodium, however, that I prefer to explain our peculiar relations to sodium chloride as due to the marine origin of vertebrates and the consequent adaptation of these forms to life in a somewhat concentrated solution of this salt.

Other physiological antagonisms which are often mentioned are

[1] Schloss, *Biochem. Z.*, 22, 283–89.

[2] Borchardt, *Deut. med. Wochenschr.*, 38, 1723–27.

those between calcium and magnesium and between calcium and sodium; other less important ones have been shown to exist between chlorine and iodine, and between chlorine and bromine.

The retention of the minerals is also prominently affected by their relative abundance in comparison with the requirement, that is, by the so-called "law of minimum," the least abundant constituent, as compared with the demand, serving largely to determine the usefulness of others with which it is associated in metabolism. The various salts of the diet also affect the solubility of others of this same group of nutrients in important ways.

The net result of these interrelationships among the mineral nutrients is likely to be manifest as a prominent lack of correspondence between the retention and the intake of these substances. The man to whom quantitative relations in mineral metabolism appear to be simple and direct is not embarrassed by an acquaintance with much of the evidence.

Calcium, phosphorus and iron are more likely than other mineral nutrients to be lacking in human dietaries. On this account especial interest attaches to their occurrence in food. Calcium is especially abundant in milk, and is also contained in considerable quantities in eggs, vegetables and fruits. Phosphorus is abundant in milk, eggs, nuts, peas, beans and such cereal products as contain the outer seed coats. Iron is found in largest quantities in beef, eggs, beans, peas, green vegetables (especially spinach) and in the outer seed coats of the cereals. The foods which are poorest in minerals are polished rice, pearl hominy, white flour, bolted cornmeal and other cereal foods which lack the outer seed coats. These foods, because of their highly digestible character and lack of salts, are apt to be constipating. Magnesium is abundant in the cereals and is not apt to be deficient in normal rations. The magnesium salts of the outer seed coats of cereals contribute a laxative character to foods containing them. Enough sulphur is contained in the proteins of any ration which supplies the nitrogen requirement. Potassium is found in considerable quantities in most normal foods and is also present in sufficient amount in almost all diets.

Manganese, boron, silicon and iodine are among the less abundant minerals in the body, the presence of which in the necessary quantities in the diet we take for granted. We are just now finishing up in my laboratory iodine estimations on about 950 samples of food products in a study which will show in what foods iodine is found, and which may perhaps show a relationship of the iodine of foods to the prevalence of goiter.

Considering the proportion of minerals to other nutrients needed during the several stages of life, there is, from birth to maturity, in general a decreasing requirement, but with periods of increased demand due

to unusual functional activity, especially during puberty, pregnancy and milk secretion. The usual mineral requirements of mature human beings are comparatively slight, and are probably satisfied by all normal diets (provided we specify with some particularity as to what constitutes a normal diet). It is, therefore, during rapid growth and during the reproductive life of women that the mineral nutrients are especially in demand, and it is at these times that lack of mineral nutriment and irrational hygiene cause or aggravate a number of well-known pathological conditions which are characteristic of these states of being. We shall mention in detail the mineral requirements at some of these times of greater need.

The normal food of the human infant naturally furnishes its full mineral requirement. This subject becomes of interest in this connection, therefore, in cases of artificial feeding and in certain metabolic derangements. For an artificial food we naturally turn first to cow's milk, which because of high fat and casein contents must be liberally diluted. If water is used, the necessary dilution reduces the minerals, the albumin, the lecithin and the so-called accessory nutrients to an undesirable extent. The best diluent is whey, which any one can prepare with the aid of a thermometer and a commercial rennet preparation in a few minutes. (The whey must be heated to 68°C. or 154° Fahrenheit to kill the enzyme, before it is mixed with milk.) With combinations of whey, skim milk, cream and milk sugar you can play any dietetic tune you please on the infant organism, and with these foods the intelligent parent can rear any infant which can live at all. The especial usefulness of whey is due to its abundant mineral content in natural physiological solution. It serves as a stabilizer—a corrective. You can do no harm with whey unless you use the evaporated preparation, whey powder. It is possible by an abuse of this food to cause edema (in weak infants) through excessive ingestion of minerals, though this would never occur in its proper use.

The commonest metabolic disturbance in infants is gastrointestinal indigestion. Its commonest cause is a weak digestive apparatus and too much fat in the food. Alkali soaps, formed in the intestine, instead of being digested and absorbed are passed off in the feces. Alkalis are lost to the organism; mineral acids are left to predominate; infantile acidosis ensues. What shall we do? Reduce the fat in the food and add sodium citrate to furnish an oxidizable alkali salt.

Because of its low oxidative capacity the infant organism is especially subject to acid intoxication from relatively slight causes, the acid excess being due to the normal acid products of metabolism and to imperfectly oxidized organic compounds, especially betaoxybutyric acid. We have mentioned the weak digestive apparatus and deficient capacity to handle fat. Inanition also causes acidosis in infants. Fever is a

very common cause. In all these cases whey is especially valuable. Many a child has been taken through long sieges of fever on whey. Children do not lose weight rapidly on whey alone. Egg white and fruit juice, especially that of the orange, may be used with whey to advantage; they furnish some nutriment and appreciable amounts of alkali.

The infant is born with a store of iron within its body. During the nursing period this store is gradually depleted, since the milk contains little iron. At weaning time the infant stands in need of iron. This is usually supplied in egg yolk, beef press juice, scraped beef, prunes, whole wheat foods and oatmeal, and some physicians of unquestioned standing recommend spinach. I happen never to have seen spinach used, however, for an infant. Egg yolk is of especial value as a source of iron, calcium, phosphorus and lecithin. But it is an exceedingly rich food. It must be fed with great care on two accounts, first, to avoid making the baby sick, because while it is usually well taken it acts like poison to some infants, and second, because the value of egg is so great that it is especially unfortunate if you upset the infant by an overallowance, since it may be a long time before it will regain its tolerance for this food.

In connection with the mineral metabolism of infants mention must also be made of rachitis. The cause of this disease is unknown. It is not due *primarily* to lack of minerals in the diet and does not respond readily to simple increase of minerals in the food, though calcium salts administered with phosphorized cod-liver oil are usually beneficial.

The existence in infants and older children of simple malnutrition of the bones, a common malady in young farm animals, is not well established; and the prevalent imperfections of children's teeth are not certainly related to deficiencies in the diet, but seem rather to be caused by lack of exercise (due to the fine milling of our cereals and the chewing of our meat with a sausage mill), the increasing use of sugar (a readily fermentable, acid-producing food) and increasing use of fruits, the organic acids of which soften the tooth enamel.

In considering the mineral requirements of human beings we may bear in mind the facts that more than three fourths of the ash of the body is in the skeleton, which includes about 88 per cent. of the phosphorus and more than 99 per cent. of the calcium of the entire body. Thus in discussing mineral requirements of the organism as a whole we have to do very largely indeed with the skeleton, but we must not overemphasize these facts, for the quantities involved are no gauge of functional importance, as is illustrated by the fact that iodine, which is found in the body in infinitesimal amounts, is just as essential as the pounds of calcium.

Beyond the period of infancy the mineral nutrient which is most commonly lacking in the diet is calcium, though phosphorus also may be

deficient, and the iron content of the diet is sometimes inadequate, as evidenced by the existence of anemia in children.

For purposes of growth our best single sources of mineral nutriment are milk and eggs. Of these, milk lacks only iron, and eggs only calcium. The incubating bird supplements the moderate calcium content of the egg by absorbing an appreciable amount of lime from the shell.

During the reproductive life of women liberal use should be made of the iron-containing foods, such as beef, eggs, fruits and green vegetables, especially spinach, green beans and cabbage. Lactation makes a heavier demand upon the mother for mineral nutriment than any other incident in her life, and the most efficient method of providing the mineral requirement is, naturally, through the use of milk, or foods made from milk.

In old age there seems to be an absorption and loss from the body of much bone substance coincident with the general atrophy of the tissues. This is most apparent in the receding of the processes of the maxillæ and the absorption of the spongy structure of the interior of the long bones. This appears to be a physiologic process, and we have no evidence that it is affected one way or the other by the minerals of the diet, though it is conceivable that there might be some such influence.

Generally speaking, a high ash content of the food is desirable, since the organism is much better able to handle an excess of ash constituents than to meet a deficiency. It is good practise, therefore, to utilize the water in which foods are cooked, in so far as this can be done without detracting from the acceptability of the food, since the cooking-water dissolves out much mineral matter. An abundance of mineral salts in the diet is also desirable, aside from nutritive considerations, because they contribute a laxative character to the food. Foods which are deficient in minerals are apt to be constipating.

A general character of the mineral nutrients of foods is the predominance of acid or basic elements. If the nutrients are present in the proportions in which they are needed the bases will predominate, and it is probably best that the bases should exceed the acid elements in the diet. It is true, however, that the organism has the capacity to neutralize a considerable excess of acids. Meats, eggs and cereals have acid ash; vegetables, milk and most fruits have alkaline ash. The latter group should be liberally represented in the diet.

The diets which are most likely to supply enough of each of the minerals are those characterized by liberality and diversity. Extreme simplicity of diet is not advantageous. The usual diets of prosperous Americans do not lack mineral nutrients. But we are not all prosperous, and some of us choose unusual dietetic combinations. The central features of improperly chosen diets are usually an undue dependence upon meats and foods made from finely milled cereals or other cereal

foods lacking the outer seed coats, and too little use of milk and vegetables.

Those circumstances most likely to lead us into error in this matter are ignorance, poverty, parsimony, dietetic fads, peculiarities of appetite and disordered digestive functions.

Now in conclusion, it is certainly true that we muddle along fairly well without much attention to this subject, but one never knows when he may need additional insurance in the way of understanding. Through my slight knowledge of this subject I was able to save my own son, and that of course seems to me to have been worth while. Then too, when there be no lives in danger, there is a certain satisfaction which we all take in efforts to direct our affairs with intelligence even though "the worst laid plans of mice and men gang oft aright."

THE CHEMICAL NATURE AND PHYSIOLOGICAL SIGNIFICANCE OF SO-CALLED VITAMINES

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IT has been known for some time that scurvy is a disease which occurs in man and certain higher animals when the diet does not contain fresh vegetable or animal foods. Once the disease has made its appearance it can be cured in most cases in a remarkably short time by the introduction into the diet of the patients of a sufficient amount of fresh vegetables, fresh milk and especially fresh lemon juice. Hence it is obvious that these last-mentioned foods contain in their fresh state substances which are essential for the prevention of scurvy. As a diet which otherwise is fully adequate from the point of view of its content in proteins, carbohydrates, fats and calories may lead to scurvy, the logical conclusion is that there exist in fresh vegetables and certain animal foods substances of an unknown chemical composition which are essential accessory foods.

The deficiency of the diet in similar substances may give rise to a disease of the peripheral nervous system, known as beri-beri, which is especially prevalent in eastern countries, as Japan and the Philippines. People living on a diet which consists almost entirely of highly milled rice or wheat are very apt to develop beri-beri after having lived on this diet for a period of ninety days. On the other hand, beri-beri does not develop in persons living on whole rice or wheat flour. In other words the outer portions of these cereals, namely the aleuron layer, contain the substances which have to be added to the diet in order to prevent this disease. As in the case of scurvy, a considerable number of observations have established the fact that beri-beri is not due to a deficiency of the

diet in proteins, carbohydrates or fats, but that certain accessory food substances are lacking in the diet. For this reason we speak of scurvy and beri-beri as deficiency diseases, meaning by this term that the diet which is responsible for the production of these diseases is deficient in certain accessory foods having no direct relation to the protein, carbohydrate and fat content of the diet. Funk has designated these accessory foodstuffs as vitamines, meaning that they are essential for life.

It is fortunate that most people on account of their dietary habits live on a mixed diet containing enough of these accessory foods to prevent an outbreak of scurvy or beri-beri. Little can be said, however, at the present time as to the influence of a deficient diet on health, the deficiency of which is not pronounced enough to produce scurvy, beri-beri and other, as yet unrecognized, deficiency diseases. It is only reasonable to assume that such an incomplete deficiency might lead to milder symptoms which are only fully pronounced when the disease has made its appearance. From the foregoing it is evident that the scientific and practical importance of these accessory foodstuffs or vitamines can not be overestimated and their bearing on nutrition and the maintenance of health represents a most interesting scientific chapter. I shall therefore attempt to review the most important discoveries which have been made in the last few years in this field.

The first fact which seems fairly well established is that the substances preventing beri-beri or the anti-neuritic substances are present in the natural foods largely in a combined form which is soluble in 90 per cent. alcohol or water, and when present in sufficient amounts in the diet will prevent the occurrence of beri-beri. This mother substance can be split by means of acid hydrolysis or autolysis by means of enzymes, yielding after fractionation a substance with very powerful curative properties if tested on patients with symptoms of beri-beri; especially the so-called wet beri-beri is cured by this preparation in a few days. Very little is known at present as to the chemical nature of the mother substance of this beri-beri vitamine. The observations that foods rich in lipoids are also rich in vitamines and the solubility of the mother substance of the anti-neuritic substance in alcohol might lead to the belief that vitamines enter into the molecule of certain lipoids, an assumption which recent experiments by Dr. Sullivan and myself[1] have made highly improbable. The anti-neuritic vitamine is probably not in combination with carbohydrates, as the starchy part of cereals seems to be extremely poor in this substance. The possibility that certain parts of the protein molecule, especially the nucleic acids, may hold in combination the active substances is still open and the fact that foods rich in nucleated cells are also rich in anti-neuritic substance might perhaps be considered as evidence of the truth of this assumption.

[1] *Proceedings Amer. Soc. Biol. Chemists,* 1915.

From these considerations we may conclude that the anti-neuritic vitamine is present in foods in a combined form, which is much more resistant than the free curative substance. This is of great practical importance, as in the process of cooking we subject food for a considerable length of time to a temperature of about 100° C. As will be seen later, the more or less isolated beri-beri vitamine loses its physiological activity under these conditions.

It is obvious that the chemical isolation of vitamine from foods is of great importance in order to enable us to study their chemical nature and physiological action. A considerable amount of work along this line has finally led to some degree of success. We are especially indebted to Funk[2] for a method which makes it possible to obtain the anti-neuritic substance in a more or less pure form of very powerful physiological activity. This investigator succeeded in preparing a crystalline substance, a few milligrams of which when administered to pigeons suffering from experimental beri-beri led to a complete recovery of the paralytic symptoms within a few hours. This substance contains carbon, nitrogen, hydrogen and oxygen. It seems to possess the properties of an organic base. Unfortunately the yield in active substance is very poor, even when prepared from hundreds of pounds of natural foods rich in this substance. This is due to several defects in the method. First, it is at present impossible to extract the total activity from natural foods by means of alcohol, the common solvent used for this purpose. Second, the use of alkalies and oxidizing agents employed in Funk's method destroys the anti-neuritic vitamine very easily. Work is in progress in my laboratory to overcome these difficulties and I may state that several new modifications of the method have been discovered which seem to improve the yield considerably. It is interesting to note that adsorbing agents, such as charcoal, etc., will completely remove the anti-neuritic substance from its solutions. Such solutions also lose their physiological activity by boiling for a few minutes after sufficient alkali has been added to render such solutions alkaline.

As far as the anti-scorbutic vitamine is concerned it has been impossible to isolate it up to the present time. All we know about this substance is that it is fairly stable in acid media. This is probably the reason why lemon juice, with its high acidity, is the classical preparation used in the prevention and treatment of scurvy.

For the same reason milk, having an amphoteric reaction, on being heated for a considerable length of time to a temperature exceeding 100° C. loses its anti-scorbutic properties and in forming the exclusive diet of children may give rise to the appearance of infantile scurvy.

The physiological and pharmacological properties of these vitamines have not been studied extensively. The main facts which have been

[2] C. Funk, "Die Vitamine," 1914.

established are that these preparations, obtained in the proper way, do not possess toxic properties, and that in remarkably small amounts they relieve the symptoms in animals and men suffering from deficiency diseases. The mechanism of this pharmacological action is still obscure. Observations made on the vitamine content of the spinal cord have shown that nerve fibers do contain the anti-neuritic substance, mainly in a combined form, which is liberated after autolysis of the tissue. From this it would appear that the anti-neuritic substance under normal conditions formed an essential part of the nerve fiber, and its presence in nerve tissue in sufficient amounts is essential for the proper function of this organ.[3]

An interesting relation between carbohydrates and anti-neuritic substance was discovered by Funk,[4] Braddon and Cooper.[5] It was found that in order to prevent the occurrence of experimental beri-beri in pigeons it is necessary that for each gram of carbohydrate in the diet there must also be present a certain minimal quantity of anti-neuritic substance. If the carbohydrate component of the diet is increased the vitamine content must be increased accordingly. This explains the earlier observations that a diet rich in carbohydrates is more apt to give rise to the appearance of beri-beri.

In conclusion a few considerations concerning the practical bearing of these accessory foods or vitamines on nutrition in health and disease may not be out of place. The following table illustrates the relative vitamine content of foods, beginning with those richest in vitamines. I do not pretend that this table is a very accurate compilation, but in our present state of knowledge it will probably be found of some use in deciding questions as to what constitutes a satisfactory diet from this point of view.

TABLE

Anti-neuritic Properties		Anti-scorbutic Properties	
Relatively Rich	Relatively Poor	Relatively Rich	Relatively Poor
Brewer's yeast	Sterilized milk	Fresh vegetables	Dried vegetables
Egg yolk	Sterilized meat	Fresh fruits	Dried fruits
Ox heart	Cabbage	Raw milk	Sterilized milk
Milk	Turnips	Raw meat	Canned meat
Beef and other fresh meat	Carrots and other vegetables of this type		Dried cereals
Fish	Highly milled cereals		Pork fat
Beans	Starch		
Peas	Pork		
Oats			
Barley			
Wheat			
Corn			

[3] Voegtlin and Towles, *Jour. Pharmacol. and Exp. Ther.*, 1913, Vol. 67.

[4] Funk, *Zeitschr. f. physiol. Chem.*, 1914, IX. C., 378.

[5] Braddon and Cooper, *Jour. Hyg.*, 1914, XIV., 351.

It is obvious from this table that a mixed diet including sufficient animal foods, as fresh milk, eggs, meat and fresh vegetables is by far the most satisfactory diet, as it contains sufficient anti-neuritic and anti-scorbutic substances. The dietary habits of the greater part of the population in this country are such as to prevent the continuous consumption of a diet deficient in vitamines. In recent years, however, certain factors have had a tendency to reduce the vitamine content of the diet of the population at large. Changes in our economic conditions, food production and method of cooking seem to reduce the vitamine content of the diet of a large number of persons to the danger-point. Observations which I have made in connection with studies on the cause of pellagra bear out this assertion. The population of a large portion of the southern states, in which this disease is prevalent to such a serious degree, lives on a diet which is, to say the least, not rich in vitamines. Highly milled cereals, pork fat, in addition to cabbage and turnips and similar vegetables, form the staple article of the diet. The customary use of baking-soda in the preparation of food furthermore lowers the vitamine content of the diet. I have been able to demonstrate on animals that corn bread made from cornmeal and milk with the addition of soda loses its high initial content of anti-neuritic substance in the process of baking as a result of the destructive action of the alkali. The use of baking soda for this purpose should, therefore, be discouraged.

Another factor which undoubtedly enters into this question is the consumption of highly milled cereals. The staple articles of diet of a great percentage of the people in the southern states are highly milled wheat, corn and rice. The change in the milling process, leading to the making of these products deficient in vitamines, took place in more or less recent years.

The increase in the cost of living naturally tends to reduce the amount of the more expensive milk, meat and eggs in the diet and leads to a corresponding increase in vegetable foods, the latter being deficient in certain accessory foods. While it is not yet firmly established that pellagra is a deficiency disease, many facts speak in favor of such an idea. Without exaggeration it should be stated that the importance of the accessory foods is a vital problem for the maintenance of the health of the human race.

FOOD SELECTION FOR RATIONAL AND ECONOMICAL LIVING

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THERE are a number of factors which should be taken into account when one discusses diet with reference to its adequacy and economy and to the satisfaction which it gives. Among these are a knowledge of local markets and standards of food quality; wise selection of food; preparation and cookery; and the planning of meals, or, as it is so commonly called, "menu-making." The last of these is by far the most important, and will therefore be discussed at the greatest length, though the others logically precede it.

By a knowledge of markets is meant not only knowledge of the location of butchers, grocers and other dealers in food in one's neighborhood or town, but also a good idea of the reliability of the different dealers, the quality of the goods which they offer, the relation of the cash or credit systems of selling to their prices, and other such things. To be complete it should also include some understanding of the production and distribution of food materials; such information, for instance, as would lead the housekeeper to purchase local-grown goods when possible, not only because they may be fresher, but also because of the difference in their favor of transportation charges and hence of price. With respect to the quality of foods, the housekeeper should know, for instance, how to distinguish old and young poultry, and tough, overfat or overripe meats; she should know the relative merits of wilted and fresh vegetables, being able to tell when the former can be freshened or when they include too much inevitable waste to be economical. Other illustrations might be cited, but these are sufficient to show what is meant. A knowledge of markets and of quality of food products as related to final value calls for a wide range of information, much of which can be taught and some of which must be gained by experience.

Wise choice of foods involves possession of other lines of information and experience which enables the housekeeper to purchase to good advantage. She must realize that out-of-season foods, like strawberries or green peas in January, will be more expensive, and no more nutritious, than the same foods in early summer, while foods which are uncommon at all times, like fresh mushrooms, will be more expensive than cabbage or carrots, which they closely resemble in nutritive value. She may select according to her circumstances, but she should do so "with her eyes open," and not in the belief that the superior virtues belong neces-

sarily to the rare or the unusual. Then, too, one must take into account the quantities which can be handled advantageously in the home. It is the part of wisdom to purchase in quantity those supplies which can be easily stored and kept without deterioration, while such purchase would be decidedly unwise in the case of perishable foods, or if there are no proper storage facilities. One must take into account further the ability of the person who cooks to make acceptable dishes from the foods supplied. If she does not know how to make a palatable pot roast or similar dish from a tough cut of beef and does know how to broil a steak well, there may be some economy in choosing the steak. The suitability, with respect to the needs of the individual family, of the food purchased, is another important consideration. Thus, a good deal of waste comes from the purchase of meats which give too large cuts for the family tastes. For instance, if the chops purchased are so large that the individual portion which would be served (usually one large or two small chops) is larger than the eater's average appetite, part of the meat may be left on the plate and thrown away. The housekeeper, therefore, should take pains to provide materials which can be served in portions to "fit" the family tastes.

The relative amount of time, labor and fuel which is required in preparing foods for the table has a decided influence upon actual as compared with apparent cost. The busy housekeeper who wishes to prepare breakfast quickly may recognize this when she pays a higher price per pound for some ready-to-eat cereal, which at most only requires to be warmed before serving, instead of buying a breakfast cereal costing less per pound but which must be cooked for several hours. If she prefers a cereal which needs longer cooking, she should know that she can begin to cook it when the evening meal is prepared, and finish it either in the fireless cooker or while she is preparing breakfast the next morning. The more she appreciates and acts upon such considerations, the more likely she is to provide a satisfactory diet which is also an economical one.

Cookery and other matters pertaining to the preparation of food for the table are particularly important from the standpoint of economy and satisfaction. Here, as elsewhere, knowledge of the "art of dressing food," to use an old phrase, is very important. It may be learned by experience (usually at much cost), or from the mother or other members of one's family, as has been the rule in the past, or, like other arts, it may be learned in school, as is increasingly the case under the changed conditions of the present day. The housekeeper needs such knowledge, whether she applies it herself, or whether she directs some one else. If, in addition to the art of cookery, she understands relative food values and other technical matters pertaining to food and its uses, her task of providing a rational diet will be the easier.

She should not be parsimonious in her household management, neither should she be extravagant, and to this end she should understand and practise rational economy. She must realize, for instance, that a large amount of garbage means needless waste, due to carelessness, to excessive purchase, to overgenerous service, to poor cooking, or to menus which do not please the members of the family.

She should be familiar with economical practises and usages and with practical ways of saving materials, having wisdom to make use of those which are really worth while and to avoid those which merely seem economical. As an illustration, it is possible to be economical in the use of fat and yet keep up a good standard of living. This implies careful use of the fats purchased for the table and for cooking, and also the use of fats commonly thrown away. The proper "salvage" and use of chicken fat, rendered suet, bacon fat, and other fats commonly wasted, which are, so to speak, by-products of raw materials or of cookery, will enable her to economize in the amount of butter and other fats purchased as such. She may take a hint from the commercial baker, who realizes that stale bread and cake, dried and ground, can replace about one fourth of the flour used in making many kinds of cookies, cakes, and other foods. She must appreciate the importance of careful preparation of food materials and recognize that thin paring of fruits and vegetables is less wasteful than careless paring, and that soaking dried foods like navy beans, dried peaches, etc., before cooking them economizes fuel by lessening the time of cooking required. She must know that it is possible to make palatable yet economical dishes by extending the flavor of some more expensive food through a fairly large proportion of a cheaper food of blander flavor, as is done when a small amount of meat is combined with a large proportion of potatoes, carrots, and other vegetables in making a meat stew. On the other hand, she should see that it is poor economy to use a pint of cream and several eggs to save a cupful of cold boiled rice or farina which might better go into the soup kettle.

The last factor, namely, the planning of meals, is very important and places a great responsibility upon the housekeeper, since it determines whether or not the diet provides the body with all the materials it requires. It is a problem which is often well solved by the housekeeper on the basis of empirical or other knowledge, but which is almost certain to be wrongly solved if such knowledge is lacking. Certainly, it is one regarding which there is much ignorance and many misconceptions. At one extreme are those, and they probably represent the great majority, who consider their meals only in reference to palatability—a selection which may be rational if they have learned good food habits, and fortunately, there is much empirical teaching on food habits which is sound. At the other extreme are those who heed all the fantastic statements they come across regarding specific medicinal or even semi-magic virtues as-

cribed to certain foods, who place their hopes in some particular type of food materials, or who fear lest they may suffer by "eating incompatibles," and so on through the long list of dietetic fads and fancies. Many, however, are not long deceived, their common sense warning them that, if such doctrines were true and important, the race could hardly have survived its alleged dietary indiscretions. Between these extremes stand a rapidly increasing number who seriously desire to understand and apply the principles of dietetics as they are now expounded by the more generally accepted authorities.

A fundamental principle is that the diet, considered for any reasonable length of time, must supply a great variety of chemical substances combined in different ways for the "structural" needs of the body, and also must supply it with energy-yielding substances with which it may perform internal and external work. It seems apparent that a varied diet, reasonably generous in amount, is more likely to meet the body needs than one restricted or unvarying in its make up or scant in quantity. The more knowledge and judgment used in its selection, the better the diet is likely to be.

In discussing diet, the expression "balanced ration" is often used, no doubt because it occurs so often, and to such good purpose, in discussions of animal feeding. Those who employ the term should remember that the feeder of live stock not only selects the kind of food which the horse or the steer is to eat but measures the quantity. The housekeeper, the physician, and the nurse do this for the infant and sometimes for the person who is ill or otherwise compelled to live under circumstances in which the diet is definitely controlled. The housekeeper does not do this when under normal conditions she provides a meal for her family to select from and eat of at will. Such freedom of choice is compatible with rational living and should for the best ends be accompanied by rational food habits which can be early taught in childhood, or, if need be, acquired later in life. Therefore, the term "balanced" is, and is likely to remain, inaccurate for general discussions of dietetics, and the term "well-selected" should be given the preference.

The character of the meals which the housekeeper will provide is determined largely by racial and regional influences and also by fashion. In the United States the general character of the diet is like that in the British Isles, with many minor modifications contributed by the other races which go to make up our population. Thus, we have meat with potatoes and one or more other vegetables and a dessert for the simple dinner, with the addition of soup and salad for a more elaborate one. As an example of foreign influence may be cited the serving of macaroni and cheese as one of the vegetables at dinner, or the use of sauerkraut with pork.

The influence of fashion or custom is shown in such a matter as the

preference for a meal of a given type; for instance, the continental breakfast of rolls and coffee in comparison with the English breakfast of jam, toast, eggs or meat, and tea, or the American breakfast of which fresh fruit and breakfast cereal so commonly form a part, usually accompanied by more hearty foods. We may prefer one type or another, because we have always known it or because we have learned to like it, but the whole matter is chiefly one of custom; and it is the same way with other meals. Fashion also governs quite largely the choice and the combinations of foods for a given meal; for instance, there is no inherent reason why peas instead of string beans should be served with lamb, or why we should serve apple sauce with pork and currant jelly with mutton rather than the other way around. We instinctively follow conventions, but we must not overlook the importance of so following our preference that we get distinct variety from meal to meal and from day to day. The housekeeper who thinks about such matters will realize that serving sweet potatoes, white potatoes, Hubbard squash, and boiled rice at the same meal shows "poverty of invention," since she will realize that they are somehow alike, even if she does not know that all are characterized by the presence in relatively large proportion of carbohydrates. Nor would she be happier in her choice if she served such a combination of green vegetables as spinach, asparagus, cabbage, and cauliflower, since all are similar members of the green vegetable group. Most palates would be better pleased if she had scattered her dishes through several days, having white potatoes and spinach, for instance, on one day; asparagus and sweet potatoes on another day; and so on through the almost endless number of combinations of which the food list permits; and had included in the menu such other types as seed and fruit vegetables (green beans and peas, tomatoes, cucumbers, green corn, melons, and so on). Not only would this be more pleasing to the person with discriminating taste, but it would also be more desirable from the standpoint of the rational selection of foods, since a person would be more likely to secure all of the food constituents which he needed from a mixed meal than from one of such sameness.

Furthermore, a survey of the available data on the subject of meals leads us to believe that it is possible to classify them into two distinct types (though admittedly this is only a very rough division)—namely, those which, for want of a better term, may be called the "hotel" or "restaurant" type and those which may be called the "family" type. In the former the principal dish chosen is likely to be a meat order, which may carry with it a moderate serving of potato and which is supplemented chiefly by bread and butter and possibly dessert, and less often a green salad, but which usually does not include a generous order of vegetables. In the second, or "family," type of meals the amount of meat served is likely to be smaller and the proportion of vegetables

served very much larger, with dessert and bread and butter as well. If we follow the rapidly gaining theory that foods like meat, which yield an acid residue when assimilated, should be accompanied by a generous amount of foods like vegetables and fruits, which yield a distinctly alkaline residue when assimilated, the wisdom of the so-called household type of meal is apparent. We shall find also, if we consider its chemical composition and energy value, that it is more likely than the other type to supply in reasonable proportion the necessary building and repair material and the energy-yielding substances required.

The number of meals taken in a day is significant chiefly as a convention or fashion. With the reasonably generous breakfast of the American family the lunch or supper is likely to be moderate and the dinner generous. On the other hand, it is natural enough that with the light breakfast of Continental Europe there should go either the second breakfast and supper or the hearty lunch as well as the dinner. Apparently the number of meals taken does not greatly influence the amount eaten per day, for the man who goes without his breakfast is very likely to make up for it at dinner or supper, while the man who eats an early breakfast and then a second breakfast will be likely to take a moderate lunch or a light dinner. Good food habits do not permit of gluttony.

The housekeeper who tries to provide a varied menu should realize that in general variety can be secured in two ways, either by using a considerable number of dissimilar food materials or by using varied methods of cookery with a smaller number of food materials. While both methods have their uses and both should be taken advantage of, it is well to remember that the first is the one more likely to provide variety from a chemical standpoint.

As regards the amount of food required, satisfaction and rational living demand that the amounts provided should be adequate, while economy demands that the amount should not be so great as to lead to over-eating or to needless waste. It may seem generous to serve a person more than he can eat, but it is not wise, since it means material left on the plate, only to be thrown away. It is better to give a smaller serving and offer a second helping. Proper care in such matters as well as in the selection and preparation of food should mean a considerable saving. The possibility of saving is made clear by the fact that the waste observed in studies of several hundred American families ranged from practically nothing to 20 per cent. of the food purchased.

It is also apparent that good dietary habits are important. These can be taught and are best learned in childhood. We should not allow children to grow up with whims, fancies and aversions respecting their food. They can be taught to like all the ordinary foods, and this should be done unless it becomes apparent (and this rarely happens) that some article of diet is distinctly harmful because of an idiosyncrasy toward it.

For the guidance of the food expert (dietitian or other specially trained worker), dietary standards have been proposed which show the proportion of protein and energy which the daily diet should supply. Such dietary standards are designed as guides for home and institution management, and should not be confused with expressions of physiological requirement. In quantitative discussions and in comparisons, one should always distinguish clearly between "food purchased," "food eaten" and "food digested," and should take the further precaution not only to compare like things, but to compare them on a uniform basis. The basis most often selected for comparing dietaries is the food or diet of "a man in the period of full vigor weighing 150 pounds and engaged in moderate to active muscular work," and factors for computing the requirement of men, women and children in other circumstances in terms of this standard have been worked out. These precautions should always be taken in comparing the results of dietary observations, experiments and studies; otherwise, avoidable confusion results. If they are so taken into account many of the seeming differences of opinion which sometimes lead to divergent conclusions will be found non-existent. When all precautions are taken for accuracy in comparisons and discussions, differences in the amounts of protein and energy found in the diet of different persons and different races are still apparent, as well as differences of opinion as to the amount of nutrients and energy required or desirable. Such differences of opinion, however, are not so great as one might expect, and one may well conclude, from a survey of the dietary studies of different races available, that persons of like age, sex and work, given an opportunity to select, instinctively choose diets showing, when reduced to uniform terms, a decided similarity with respect to the protein and energy they supply. This is not surprising when one recalls that all reasonably normal men possess bodies and possibilities of using them which do not vary within such very wide limits. A steam-engine of a given size and type will require the same amount of fuel of a certain kind in Asia as would a duplicate engine in America, for the production of a like amount of power, and why should this not be true of the human engine as well?

A large number of dietary studies made in the United States considered in comparison with the other large number made elsewhere have led to the conclusion that not far from 100 grams of protein per day, along with 3,000 to 3,500 calories of energy, represents, for the typical man (in the period of full vigor, engaged in moderate to active muscular work), the quantities which the food purchased should supply. We have not as yet been able to test with any degree of certainty the protein optimum though data on the subject are abundant enough to indicate that the suggested value represents common race habits. With energy the case is different, for it is possible with the respiration calo-

rimeter to test the accuracy of the value suggested in any given dietary standard. Such tests show that the values given above are in accord with actual measurements of the energy expenditure of individuals under the specified circumstances of work and rest.

A consideration of the results of American experiments and other data has led us to conclude that with our ordinary food habits, involving, as they do, the use of a considerable variety of foods in reasonably liberal quantities, one is justified for many purposes in discussing dietetics on the basis of energy only, since a diet which supplies 3,000 to 3,500 calories of energy per man per day, as ours so very commonly does, almost inevitably supplies the needed protein, ash, and other constituents also. Particularly is this the case when one takes pains to include in the diet a reasonable amount of milk, green vegetables and fruit. If we accept this conclusion as rational, it enables us to go ahead without controversy until the time comes when we have more abundant knowledge of the kinds and quantities of protein we need, of the functions of mineral elements and the best ways to meet our body needs for them, and of the nature of vitamines or other regulatory substances.

It is no new thing to realize that, although empirical knowledge and experience may lead to really good results, it is easier to achieve them if there is also special knowledge and training. Thinkers and writers in the past have given their time and attention to the problems of dietetics and have left us much which is interesting and useful. That we can discuss the problems more fully and more adequately at the present time is due to the great progress made in biology, physics, chemistry, medicine and other sciences. The question comes, how can we best translate the results of scientific investigation for the housekeeper's benefit. It was natural enough that at first we should try to do this in laboratory terms and expect the housekeeper to learn them. As a result, books, pamphlets, charts, etc., have been provided for her which in many cases can not be understood without special training, and for this time and opportunity are only too often lacking. Later has come the realization that, while the specialist who follows home economics as a profession needs wide and varied technical knowledge, the woman who practises the art of housekeeping chiefly needs, aside from the skill which she gains by experience, simple statements of facts and definite methods by which she may obtain desired results. With this realization has come the attempt to formulate more simple and pedagogically correct methods of instruction, and to provide illustrative material in pictorial or graphic rather than tabular and diagrammatic form. It starts with materials and facts familiar to the housekeeper and, as far as possible, applies standards which have been tested in practical as well as experimental use. Its advocates believe that by thus bringing practise and theory into direct and vital connection, their teaching is more likely than either the

scientific or the empirical method of instruction not only to result in more rational housekeeping, but also to supply the element of culture which raises any labor to an occupation.

In its studies of methods for imparting information through its extension and other activities, the Department of Agriculture has endeavored to classify common foods in a way corresponding to their distinctive functions in nutrition. The division must be more or less arbitrary, for some foods could go almost equally well in two or more groups. Thus milk, which is a general food, is included with the protein foods because it is a valuable source of this nutrient. Bread is a carbohydrate food, a protein food, and an ash-yielding food, but it is classed as a carbohydrate food because its most obvious constituent is starch, and because we use it in the same general way as we do starchy foods like potatoes. The classification as now arranged consists of five groups, and it is the understanding that each of these groups should be represented, if not at every meal, at least once a day, and that if an excessive number of food materials from any one group are used in the course of a day the result is likely to be unsatisfactory from the standpoint of rational dietetics or of taste.

The groups may be described in terms of the dietitian as follows: (1) Foods in which protein bears a higher proportion to fuel value than it does in the well-chosen diet as a whole; (2) those in which fuel value is high in proportion to protein, owing chiefly to the presence of much starch; (3) those in which fuel value is high, owing to the large percentage of fat; (4) those whose chief value is mineral constituents and vegetable acids (the latter important from the standpoint of flavor as well as of body needs); and (5) those which (like the foods in Groups 2 and 3) have a high fuel value, but in this case due to the presence of sugar. From the standpoint of fuel value only, it is obvious that Groups 2 and 5 could be combined. From the standpoint of the well-chosen and palatable meal, on the other hand, they should be kept distinct, since sugar is frequently as important as a flavor as it is as a food.

In housekeepers' terms the groups may be described as: (1) Flesh foods (except the very fattest), milk, cheese, eggs and such meat substitutes as dried beans, peas, and other legumes, and some of the nuts; (2) starchy foods; (3) fat foods; (4) watery fruits and vegetables (excluding dried legumes and fruits which have been dried or combined with much sugar); and (5) sweets.

The grouping is easy to remember and provides a guide for the housekeeper in the selection of food materials for a meal or for a day's ration and also a means of checking up and criticizing the meals which have been served.

It is obvious that while some foods belong clearly to one group, sugar and honey to Group 5, for example, and liver and veal (which contain

Some Common Foods Grouped According to Their Characteristics
(All five groups should be represented in the diet every day)

Group 1	Group 2	Group 3	Group 4	Group 5
Foods Characterized by Protein	Foods Characterized by Starch and Similar Carbohydrates	Foods Characterized by Fat	Foods Characterized by Mineral Substances and Organic Acids	Foods Characterized by Sugars
Lean meats Poultry Fish Oysters, etc. Milk Cheese Eggs Dried legumes Nuts	Bread Crackers Macaroni Rice Cereal breakfast foods, meals and flours	Butter Cream Lard and other culinary fats Salt pork Bacon Chocolate	Spinach Peas Lettuce Potatoes Turnips Apples Oranges Berries	Sirup Honey Jellies Dried fruits Candy
And other protein-rich foods	And other cereal foods	And other fatty foods	And other vegetables and fruits, raw or cooked	And other sweets

very little fat) clearly to Group 1, other foods are difficult to classify. Mutton, for example, is a protein food which might also be classed as a fat food, and dried navy beans might be classed as a protein and also as a starchy food. To cite another example, potatoes, which are an important source of mineral substance, with some organic acid, are included in Group 4 rather than in Group 2, which at first thought might seem the more logical place for them when we recall that they are so generally used as a source of carbohydrate (starch). In general, however, the system of groupings will be found helpful.

The following sets of menus contain none but wholesome and desirable food materials. These food materials, however, have been poorly combined so far as the protein, fat, and carbohydrate which they provide are concerned. The first set is characterized by much protein, the second set by much fat, and the third set by much carbohydrate.

Menus with Protein Predominating

Breakfast: Cereal cooked in milk, chicken hash with egg, popovers, butter and milk as a beverage.

Dinner: Dried-bean purée, halibut steak, potatoes scalloped in milk, tomatoes stuffed with chopped beef, bread and butter, and frozen custard with nut cookies.

Lunch or supper: Baked beans, nut bread and butter, old-fashioned rice pudding, and a glass of milk.

The following shows a day's menus (not at all unusual or peculiar) in which fat foods predominate.

Menus with Fat Predominating

Breakfast: Oatmeal with cream, sausage, and corn bread and butter.

Dinner: Cream of tomato soup, mutton chop with creamed potatoes, greens cooked with bacon or pork, bread, and suet pudding with hard sauce.

Lunch or supper: Creamed salmon, lettuce with oil dressing, tea biscuits and butter, pumpkin pie, and a cup of chocolate.

The following is an example of three meals of combinations common enough but in which carbohydrate (starch and sugar) predominates.

MENUS WITH CARBOHYDRATE PREDOMINATING

Breakfast: An orange followed by corn cakes with maple syrup, and bread or toast and butter.

Dinner: Meat pie and baked potato, green peas, bread and butter, and cottage pudding with chocolate sauce.

Lunch or supper: Rice croquettes with jelly, rye bread and butter, baked apples, and sugar cookies.

The food and fuel values of the menus served are given below, the portions served being of the average and usual size for an adult.

THE COMPOSITION OF THE NUTRIENTS AND THE ENERGY SUPPLIED BY THE MENUS USED FOR ILLUSTRATION

	Weight of Edible Food Served, Grams	Protein, Grams	Fat Grams	Carbohydrates, Grams	Fuel Value, Calories
Protein meals:					
Breakfast	471	36	50	54	810
Dinner	772	58	64	120	1,288
Lunch or supper	639	33	38	105	894
Total	1,882	127	152	279	2,992
Fatty meals:					
Breakfast	353	24	69	58	949
Dinner	617	33	88	108	1,356
Lunch or supper	621	29	83	98	1,259
Total	1,591	86	240	264	3,564
Carbohydrate meals:					
Breakfast	509	15	32	168	1,020
Dinner	529	40	33	133	989
Lunch or supper	376	14	27	127	807
Total	1,414	69	92	428	2,816

Described in technical terms, for the benefit of the dietitian, the first day's menu supplies 4.2 grams of protein per 100 calories of energy, or 2,356 calories of energy per 100 grams of protein; the meals of the fatty menu, 2.4 grams of protein per 100 calories of energy, or 4,120 calories of energy per 100 grams of protein; and the meals of the starchy (carbohydrate) menu, 2.5 grams of protein per 100 calories of energy, or 4,081 calories of energy per 100 grams of protein.

Speaking in terms of the housekeeper; Into the first day's menu there went sixteen food materials other than fresh fruits and vegetables, of which nine were from Group 1. Milk entered into or made up ten dishes; eggs, four; nuts, two; and beef, fish, chicken, dried beans, and dried peas, each, one. Into the second day's menu went nineteen food

materials other than fresh fruits and vegetables, of which nine were distinctly fatty foods (lard, oil, butter, cream, salt pork, and others), while the meat, fish, and even the cereal chosen were those which contained comparatively high percentages of fat. Into the third day's ration went eleven food materials, of which six were starchy or sugary (rye, wheat, corn, rice, maple syrup, cane sugar).

Thus, by unwise choice one characteristic of the well-chosen diet—a right proportion between protein and fuel—was omitted.

It is hardly necessary to say that different combinations of vegetables and fruits may be made in which the proportion of mild vegetable acids and ash to the other nutrients in the total diet may vary widely—a fact which could be shown by similar groupings of food materials into menus.

To benefit by well-selected menus, each member of the family should eat all of the kinds of food provided, for, if a person habitually eliminates some particular sort of food as fruits and green vegetables, he has failed to take advantage of the housekeeper's selection, no matter how good it may be. One must, speaking broadly, relish all kinds of food, which is a matter of good habits and good manners as well as of physiological importance.

The housekeeper who will learn the simple classification of foods mentioned above can easily see the relation of the different groups of foods to the character of the meals she provides. She need only go a step further to realize that it is wiser to provide dishes varied in character for a given meal, and also meals varying from those of the same day and varying from day to day. She can do this easily by taking care to see that the different food groups are represented in at least two of the three meals she serves each day. The more extended her information as to market facilities, the wider her knowledge of standards of quality, the wiser her selection of foods, and the greater her skill in preparing and cooking them, the easier it will be for her to plan meals by this or any other method, which will be reasonable, economical and satisfactory, as well as adequate.

She can understand also that it is more important to apply the principle outlined to a considerable period of time than to a single day. A departure from the ideal for a day or so means little, for it can be made up the next day or the next week, while an irrational diet, if followed for a long period, may lead to marked disturbance or even serious illness.

The housekeeper need not go into the reasons for all these things which she has to attend to, but she will be quick to see in a general way the point of it all in so far as it concerns her problem of preparing suitable meals for her family. She need not know the theories of electricity to use and appreciate an electric light, nor need she be burdened with the theories of dietetics, if she is willing to trust the conclusions others have reached and apply them to her particular problems.

She naturally wishes for some tangible proof that her efforts to provide a rational diet as part of her good housekeeping are meeting with success. The general condition of her family should offer her fairly good evidence. Thus, it seems fair to say that the child who continues to approximate the average for his years with respect to weight and height, who is apparently normal in respect to work and play, and who exhibits none of the obvious symptoms of ill health can not be very faultily fed, any more than can be the adult who remains in fairly constant weight for long periods of time, making due allowance for the seasonal variations (such as the small loss in weight in summer and the small gain in winter), and has other attributes of good health. As one reaches middle life it is wise to be more abstemious in matters of diet, as in other things, for the body is "slowing down" and becoming less active and so needs less food. If, in any case, things do not seem to be as they should be, advice should be sought from a physician or other expert, as he alone can judge whether there is an actual departure from normal and whether it is due to diet or to some other cause.

Experience shows clearly that the experimental and the professional worker can be more helpful to the housekeeper than heretofore. The Department of Agriculture is doing what it can to accomplish this important end. The method for translating technical matters of diet into housekeepers' terms, which is outlined above, is an attempt to do this. The method can be modified as experience indicates is desirable, and the subject-matter can be amended to keep pace with the results of investigation and experiment.

What we can now do to help the housekeeper solve her problems falls short of the ideal, but, at any rate, what has been accomplished would seem sufficient to show her that her problems are recognized as worthy of study, and that an extended and consistent effort is being made to give them the attention they merit. In this movement the United States Department of Agriculture is taking part to the full extent of its opportunities.

THE PROGRESS OF SCIENCE

THE RESOURCES AND THE INVENTIONS OF THE UNITED STATES

THE annual report of the Secretary of the Interior reads less like an official government document than like a sermon or a panegyric. This is obvious from the headings of the sections, which are: National pride in development; The foundations of power; The era of splendid giving; To use, not to hold or waste; Taming the rivers for use; Places of beauty as an asset; Young America; The test of a democracy; Administrative effort. Mr. Lane, indeed, begins by defending his own method, telling us that those foreigners who write of our country often engage in facetious if not scornful comment upon our bombastic manner of telling the story of our growth and of the things achieved or possessed. But he says they fail to see far enough into the secret of our pride. "We have a passion for

THE UNITED STATES

Invention	Inventor	Date
Telephone	Bell	1876
Typewriter	Sholes	1878
Cash register	Patterson	1885
Incandescent lamp	Edison	1880
Talking machine	..do	1878
Electric furnace reduction	Cowles	1885
Electrolytic alkali production	Castner	1890
Transparent photograph film	Eastman	1888
Motion-picture machine	Edison	1893
Buttonhole sewing machine	Reece	1881
Carborundum	Acheson	1891
Calcium carbide	Willson	1888
Artificial graphite	Acheson	1896
Split-phase induction motor	Tesla	1887
Air brake	Westinghouse	1869
Electric welding	Thomson	1889
Type-bar casting	Mergenthaler	1885
Chain-stitch shoesewing machine	French & Myers	1881
Single-type composing machine	Lanston	1887
Continuous-process match machine	Beecher	1888
Chrome tanning	Schulz	1884
Disk plows (modern type)	Hardy	1896
Welt machine	Goodyear	1871
Electric lamp	Brush	1879
Recording adding machine	Burroughs	1888
Celluloid	Hyatt	1870
Automatic knot-tying harvester machine	Appleby	1880
Water gas	Lowe	1875
Machine for making barbed wire	Glidden	1875
Rotary converter	Bradley	1887
Automatic car coupler	Janney	1873
High-speed steel	Taylor & White	1901
Dry-air process for blast furnace	Gayley	1894
Block signals for railways	Robinson	1872
Trolley car	Van Depoele & Sprague	1884–1887
Harveyized armor plate	Harvey	1891

FOREIGN

Invention	Date	Inventor	Nationality
Electric steel	1900	Heroult	French.
Dynamite	1867	Nobel	Swedish.
Artificial alizarene (dye)	1869	Graebe & Lieberman	German.
Siphon recorder	1874	Thompson	English.
Gas engine, Otto cycle	1877	Otto	German.
Wireless telegraphy	1900	Marconi	Italian.
Smokeless powder	1886	Vielle	French.
Diesel oil motor	1900	Diesel	German.
Centrifugal creamer	1880	De Laval	Swedish.
Manganese steel	1884	Hadfield	English.
Electric transformer	1883	Gaulard & Gibbs	Do.
Cyanide process for extracting metal	1888	Arthur & De Forrest	Do.
Mantle burner	1890	Welsbach	Austrian.
By-product coke oven	1893	Hoffman	Do.

going into the unknown, for answering the puzzles that are put to us. Our imagination is challenged by difficulty. And the result has been a century of growth, which in its magic and in its largeness casts a spell upon the mind."

The story that Mr. Lane tells is indeed marvelous. We produce 66 per cent. of the world's petroleum, 60 per cent. of its copper, 40 per cent. of its coal and iron. Within fifty years we gave in subsidies to railroads public lands that exceeded in size a territory seven times as large as the state of Pennsylvania. We have given to the states, for the sustaining of their schools and other public institutions, an amount that our records do not accurately state, but thirteen western states were given over 67,000,000 acres. We have water power that can be made to generate perhaps as much as 60,000,000 horsepower. The waters that flow idly to the sea could be made to support not less than 50,000,000 people if turned upon the land.

Perhaps in some cases Mr. Lane overexalts our achievements. For example, he tells us that the public-school system is the most successful social enterprise yet undertaken by any people, that on it we spend three-quarters of a billion dollars a year. "Education is indeed our foremost industry, from whatever point of view it may be regarded." But we should need to double the amount spent in education to make it financially comparable with the advertising business, to quadruple it to rival the liquor trade.

Mr. Lane writes: "During the past fifty years the people of the United States have uttered two thirds of all the revolutionary epoch-making inventions of the world, ranging from the telephone and the incandescent lamp to Wright's aeroplane and high speed steel." In this case the evidence is supplied by the forty-three examining divisions of the patent office. It will not be convincing to foreign critics or to all Americans but is of sufficient interest to be reproduced.

RUINS OF THE MESA VERDE NATIONAL PARK

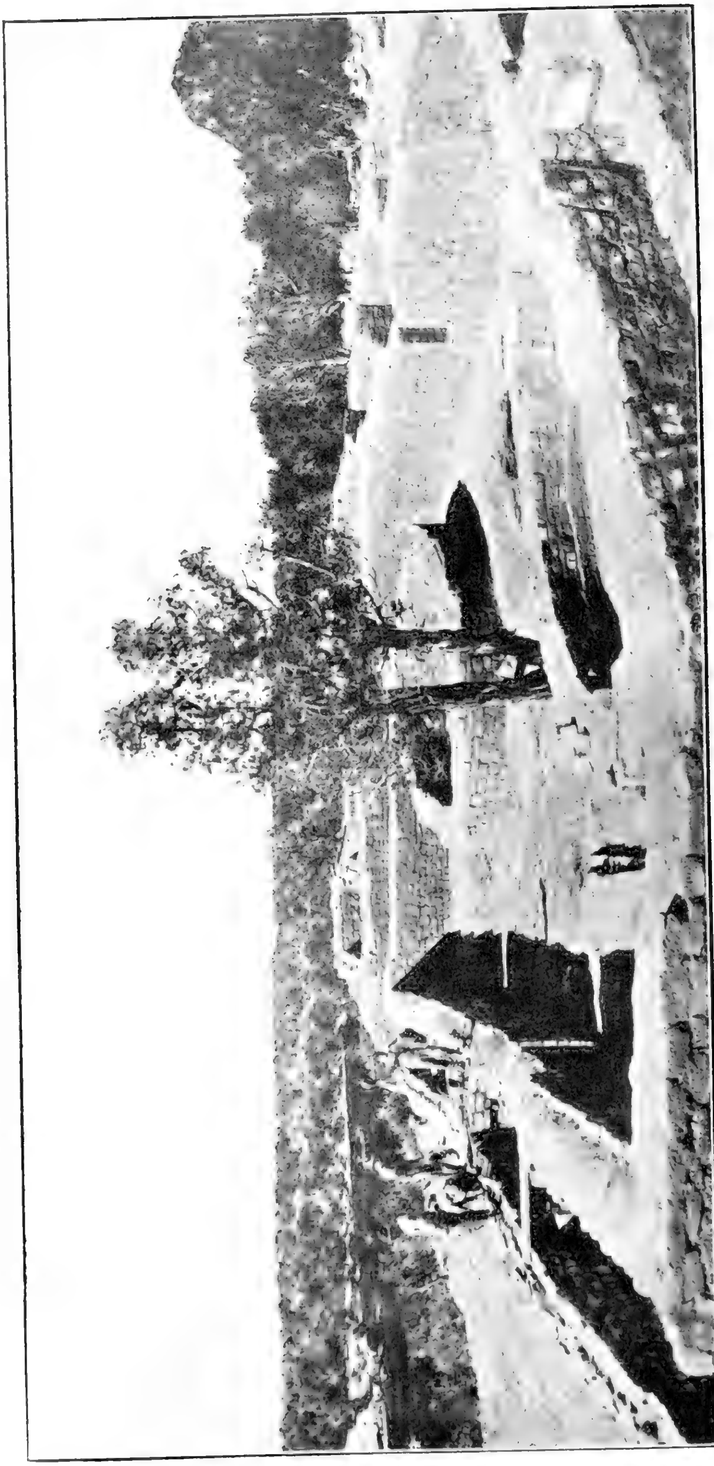
THE large tract of land in southwestern Colorado, now known as the Mesa Verde National Park, was set aside from the Ute Reservation by an Act of Congress in 1906 on account of the numerous ruins of cliff dwellings which occur in its canyons. This enlightened legislation was in response to the universal recognition that these remains had an educational importance. It was largely brought about by the efforts of women of Colorado, members of a local state organization known as the Colorado Cliff Dwellers Association. At about this time or a few years before there was a general awakening of

VIEW OF SUN TEMPLE FROM INSPECTION POINT, ACROSS THE CANYON. Also the Cliff Palace in the cave to the right.

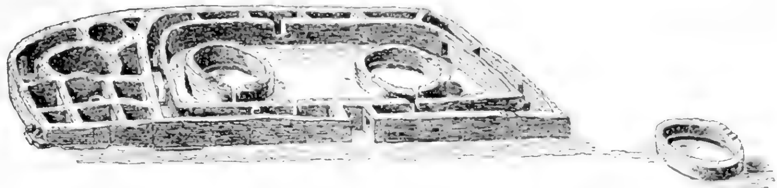
interest in prehistoric monuments throughout the country, when it was recognized that unless laws for the protection of the ruins of the Southwest were made, in a few years these survivals of the past would practically be destroyed by collectors whose efforts were mainly stimulated by the commercial value of pottery and other small objects they contained. The sequestration of the Mesa Verde National Park was accompanied by an appropriation of money for its development: payment of salary of a superintendent, building roads and current expenses. The administration of the park was naturally placed in the hands of the custodian of public lands, the Secretary of the Interior. This official wisely set aside a part of the appropriation for clearing the fallen débris from the rooms, and making such repairs as were needed for preservation of the walls. As this kind of work is of a scientific character, the Secretary of the Smithsonian Institution was called upon to designate an archeological expert to take immediate charge of the work.

The policy adopted by the Secretary of the Interior has been continued from year to year with satisfactory results. Three of the largest and most typical cliff dwellings of the park have been excavated and repaired; roads have been constructed to them, so that now the student or tourist can visit, by automobile from Mancos, on the Denver and Rio Grande Railroad, without discomfort, the well-known cliff dwellings called Spruce-tree House, Cliff Palace and Balcony House.

Up to last summer the Mesa Verde National Park was widely known from its cliff dwellings, but archeologists were cognizant of mounds indicating villages situated on the mesa top. Although the walls of buildings were not visible projecting above the surface it



VIEW OF SUN TEMPLE FROM THE TOP OF A TREE EAST OF THE RUINS. Men cementing on the top of the east wall.



SKETCH OF THE PREHISTORIC SUN TEMPLE.

was believed that there were buildings of a different type of architecture hidden below these mounds, and it was recognized that it would be well to open up one of these mounds and examine its contents, in order to enlarge our knowledge of the culture of the prehistoric inhabitants of this region.

One of these mounds is situated on a commanding promontory across Cliff Canyon, opposite Cliff Palace, or between the former and a side branch following the same general direction. The stones artificially worked that covered the surface of this mound gave indications of important results, but the extent of the mound was hidden from view by a growth of cedar and other trees. A shallow excavation had been made at one point by "pot hunters," which revealed a section of wall and confirmed the belief that rooms were buried below the mound, but the fragment thus brought to light gave no indication of the extent, shape or purpose of the building to which they belonged.

The scientific field work on the park, in 1915, was entrusted to Dr. J. Walter Fewkes, ethnologist in the Bureau of American Ethnology, of the Smithsonian Institution, who had in previous years excavated and repaired Sprucetree House and Cliff Palace. The plan of work was a complete excavation of the mound, repair and study of the building, if any within it, and an investigation of its character and purposes. A report of this work has just been made to the Secretary of the Interior in which a popular exposition of the discoveries is treated. The statements made in this report indicate that this building belongs to an architectural type hitherto unknown in the Mesa Verde National Park, and differs from any formerly described. Its ground plan is well compared to a letter D, the straight side or south wall overlooking the point of a promontory measuring 121.7 feet from east to west; the curved portion being approximately 340 feet, while the breadth is about 64 feet. A marked feature in form which strikes one at first sight is the remarkable unity in its construction, the fine masonry of the walls and their massive character. Although apparently constructed in two sections at different times, it is evident that this huge, mysterious structure is a unit and followed a plan that was thought out before the foundations were laid, the massive walls being completed without essential modification. The building was not made up of rooms patched one on the other, from time to time, as is generally the case with cliff dwelling architecture.

A PREHISTORIC SUN TEMPLE

In his official report the author after considering various details takes up three of the many questions ordinarily asked by visitors, viz.: What is the age of the building, the kinship of the builders and the purpose of its construction. There is no doubt that it was prehistoric, for a large cedar tree with 360 annual rings was found growing on the highest point of the mound, on top of the walls before excavation began. This tree sprouted as far back as 1540, or the time the discoverer of the Southwest, Coronado, first entered what is now southern New Mexico. The number of stones filling the rooms covered

by the débris indicates that the walls were formerly considerably higher and had fallen before the tree began to grow. If restored to their former place they would raise the wall six feet. The construction of this wall implies a time still further back. While the exact age can not be determined, the mound of débris would imply at least two centuries between laying the foundations and the sprouting of the cedar tree.

The purpose of the building is, and will remain, a mystery, but by elimination of theories which can not be accepted, the author believes it was a building devoted to ceremonials, or a temple. Unfortunately for all theories of use, the indications are that the walls were never finished. The rooms are not suitable for living rooms and the building shows no signs that it was intended for habitation. There are no indications of piles of débris, nor were utilitarian objects, like pottery, found in the rooms; no marks of smoke or plastering appear on the wall. It was never roofed. The theory that it was used solely for a fortification is equally unsatisfactory: there are no portholes, or places where its defenders might stand; no reservoir to supply water to warriors. Like the theory of defense, the suggestion that it was used for storage of food is likewise indefensible. Although protection and storage may have been secondary purposes, the shape of the rooms and their character implies that it was not primarily constructed for these ends. Not being able to accept any other theory, there remains but one other which strongly appeals to the author, which is that this large building was constructed for ceremonial uses. In support of this theory are mentioned certain large rooms, identified as kivas, which we know the cliff dwellers devoted to ceremonial rites. Similar rooms used for the same purpose survive in pueblos of the present day. Other reasons are advanced supporting the belief that this building was intended for a temple. The key to the whole structure, following this interpretation, is a shrine built on the corner-stone, under the southwest corner of the ruin. The symbolic figure on the floor of this shrine is a fossil palm leaf, identified as a representation of the sun, and suggesting the name, Sun Temple.

The question, Who built Sun Temple? is not less difficult to answer satisfactorily than those of its age and purpose. It has significant resemblance in architectural form to one of the great pueblo ruins in the Chaco Canyon, and the circular room of the annex with its surrounding chambers suggests the double walled "towers" found in the McElmo Canyon, and along the lower course of the Mancos River. There are deep-seated resemblances in the architectural and ceramic characters of these regions referred to which indicate that they belong to the same culture area, and it is possible that the center of diffusion of this culture was the Mesa Verde region. Although Sun Temple belongs to a type different from any of the well-known cliff dwellings of the Mesa Verde National Park, it shows evidences that it was not built by people from a distance but by inhabitants of the cliff houses of the Mesa Verde.

SCIENTIFIC ITEMS

We record with regret the death of Dr. C. Willard Hayes, formerly chief geologist of the U. S. Geological Survey; of Dr. John Orren Reed, professor of physics at the University of Michigan; of Dr. Oswald Külpe, professor of philosophy and psychology at Munich; of Dr. Richard Dedekind, professor of mathematics at Brunswick, and of Mr. A. D. Darbishire, lecturer on genetics in the University of Edinburgh.

The Bruce gold medal of the Astronomical Society of the Pacific has been awarded to Dr. George Ellery Hale, director of the Mount Wilson Solar Observatory.

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PROBLEMS ASSOCIATED WITH THE STUDY OF CORAL REEFS[1]

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HARVARD UNIVERSITY

The Visible Features of Coral Reefs.—One of the most striking features of coral reefs is their incapacity to reveal the conditions of their origin. True, the observer on a reef, whether he is a zoologist or not, may see the extraordinary luxuriance of coral growth, and may discover that the heavier forms grow under the surf on the outer slope, while the more delicately branching forms frequent the quieter waters of the lagoon. The variety of pattern and the delicacy of coloring, as seen in the clear and quiet lagoon waters, are endlessly entertaining; but it is

FIG. 1. FRINGING REEF, SOUTHEAST END OF NEW CALEDONIA; LOW TIDE. This is the inner part of the reef flat shown in Fig. 2. The slender trees on the headland are the New Caledonian araucaria, or pine.

exceptional for them to be laid bare at low tide over broad surfaces, as they are in the Great Barrier reef of Australia, so wonderfully pictured in Saville Kent's notable volume. Hence unless the traveller is fore-

[1] Presented at the Washington meeting of the National Academy of Sciences, April 20, 1915.

warned he will be disappointed in the dull gray coral rock that prevails over the greater part of the reef flat, Figs. 1 and 2, strewn with scraps of dead coral, and holding living forms only in its little pools—occasional small corals, large dark-blue starfish, sea urchins with a small number of heavy brown spines or with a larger number of long hat-pin-like black spines, giant clams with many colored mantles lining their slightly open valves, and various kinds of calcareous algæ. He will often see large masses of coral, sometimes ten or fifteen feet in diameter, that have been torn by waves, Fig 2, from the outer face of the reef, now scattered over the reef flat, suffering slow disintegration as they are battered by later storms and shifted across the flat toward the lagoon; and in the

FIG. 2. REEF FLAT, SOUTHEAST END OF NEW CALEDONIA; LOW TIDE.

lagoon he will find patches of growing corals surrounded by white coral sand or gray silt that is swept from the reef flat.

If he be a zoologist, he will revel in the opportunity of study in so superb a natural aquarium; he can there find the coral larvæ to be free-floating forms of pin-head size that are carried far and wide by ocean currents—some of them to add to the population of existing reefs, most of them to die in deep water, and a few to arrive by lucky chance on a reef-free coast, where they may establish themselves, if the temperature be high enough, and in time form a new reef close along the shore, known as a fringing reef. With wider experience, supplemented by sounding and dredging, the observer will learn that reef-building corals do not grow in turbid water, or at greater depths than 20 or 30 fathoms, or in latitudes where the winter temperature of the water is lower than 20° C. He may by wandering on many reefs gain acquaintance with

their various forms—fringing reefs, close along shore, as already mentioned; barrier or encircling reefs, Figs. 3 and 4, separated from their

FIG. 3. BARRIER REEF, NARROW LAGOON, AND EMBAYMENT, NORTH SIDE OF NGAU, FIJI. In the mid-foreground a branch valley descends to a small delta on the side of the main-valley embayment.

mountainous central island by a shallow lagoon half a mile or several miles in width; or atolls, precisely like barrier reefs, except that their lagoon has no central island; and he may, by imagination, gain appre-

FIG. 4. SURF ON THE BARRIER REEF OF RAIATEA, SOCIETY ISLANDS; HALF TIDE.

ciation of the secondary and larger meaning of the term, coral reef; for, as employed by Darwin, Jukes, and others, it means not only the visible structure at sea level, but also the whole calcareous undermass that has been added in bench-like form around its foundation; of small volume in narrow fringing reefs, probably of enormous volume in large atolls.

During these entertaining wanderings and reflections the observer may consciously, yes, insistently, review the various theories by which the origin of coral reefs has been explained. But so long as he confines his attention to the sea-level reefs, he will not be able to make sure which one of the eight or nine competing theories is the right one: for sea-level coral reefs reveal only their existence in the present, not their origin in the past. Apart from indications as to limiting depths and temperatures, as just stated, the visible reefs give no conclusive testimony as to the conditions and processes of their past formation. It is probably for this reason that so many contradictory, mutually irreconcilable hypotheses concerning the mode of reef formation have been invented. There was, to be sure, a period from 1840 to 1870 when Darwin's theory of upgrowth during intermittent subsidence, gained universal acceptance; for it completely superseded a few earlier theories and for a long time had no competitors. But after undisputed success for a generation, several rival hypotheses were brought forward, and then for some thirty years the universal agreement previously prevailing was succeeded by many and wide differences of opinion. The truth of the matter is that, during this period, the coral-reef problem has been encumbered by the rivalry of several immature, imperfectly argued, and really incompetent hypotheses, whereby progress has been embarrassed if not hindered. But during the past thirteen years several Australasian students of coral reefs in the Pacific, and for a shorter period a few students in the Atlantic, have been finding evidence that has led them to set aside the newer unsatisfactory views and return to or towards Darwin's theory. Such was the condition of things, when, aided by a liberal grant from the Shaler Memorial Fund of Harvard University and by a generous subsidy from the British Association for the Advancement of Science, which carried with it an invitation to attend the colonial meeting in Australia, I was enabled to spend the greater part of the year 1914 in visiting a number of reef-encircled islands in the Pacific ocean, for the purpose of examining on the ground as carefully as possible the merits of the various theories that have been brought forward in explanation of these extraordinary structures.

Theories of Coral Reefs.—Before starting on this journey, I made a preparatory review of the rival hypotheses,[2] in which I was aided by several references supplied by Dr. T. W. Vaughan, of Washington, whose

[2] The Home Study of Coral Reefs, *Bull. Amer. Geogr. Soc.*, XLVI., 1914, 561–577, 641–654, 721–739.

studies of Atlantic reefs began some years before mine were undertaken on the Pacific. In this review especial attention was given to the critical tests by which the success of the several theories could be measured, and the review confirmed me in the belief that Darwin's original theory, invented, as he tells us, before he had ever seen a true coral reef, is by far the most successful of all. I say "confirmed in the belief," because earlier still, I had prepared a diagram to set forth the special merits of Darwin's theory, as they were then understood: indeed twelve years ago my opinion favoring Darwin's views was briefly stated in a small text-book; but, it is regrettable to add, such was the weight of authoritative counter statements that my belief in Darwin's theory was for a time weakened; yet it was soon strengthened again when making the preparatory review over a year ago. This must be made plain, so that any one may estimate for himself whether, in what is now to follow, my presentation of the case is prejudiced, and particularly whether I am guilty of that grievous error known as "special pleading"—arguing in favor of some favorite theory—instead of giving impartial consideration to all. My preference would be to make an impersonal, objective presentation of the problem; but inasmuch as a number of different theories must be examined, some attention must be given to the experience, the qualifications and the methods of their inventors; thus the discussion inevitably becomes somewhat personal. One of the most interesting results of the preliminary inquiry of a year ago was that an investigation of the coral-reef problem inevitably leads far away from the direct study of corals and coral reefs, and enters upon the discussion of many other problems which at first might seem to have no relation to it: it is for that reason I have entitled this address: "Problems associated with the Study of Coral Reefs."

Methods of Investigation.—Now if coral reefs themselves are so uncommunicative as to their past history, the search for their origin—whether they are fringing reefs, close alongside of an island or a continental shoreline, or barrier reefs, separated from the shore by a shallow lagoon, or atolls standing alone in the ocean—can not be successfully prosecuted until the fundamental problem of how to conduct a scientific investigation of this kind has been duly considered. Let me therefore state briefly that the method of investigation which is here selected—it is more fully set forth in the preparatory review above referred to—demands, first, the observation of pertinent facts and the review of published observations by others: then, spurred on by the spirit of wondering inquiry and aided by related knowledge, it appeals to speculation, imagination and invention, or borrows from the speculation, imagination and invention of others, in the hope of thus coming upon the mental concepts or "hypotheses" of all the possible ways in which reefs could ever have been formed; and when this has been done the investigator arrives at the ponderous question: Which one of all these hypoth-

eses is right? He might at first answer this question by saying: Visit the reefs themselves with the various theories in mind, and see which one best accounts for the facts there observable; but if this advice is literally followed, no satisfactory result is obtained from it, for the reefs are so complacently indifferent that they make no objection to any one of the eight or nine theories that have been proposed to account for them. Of course they make no objection, for no theory would get so far as being announced if it did not at least explain the visible facts of the

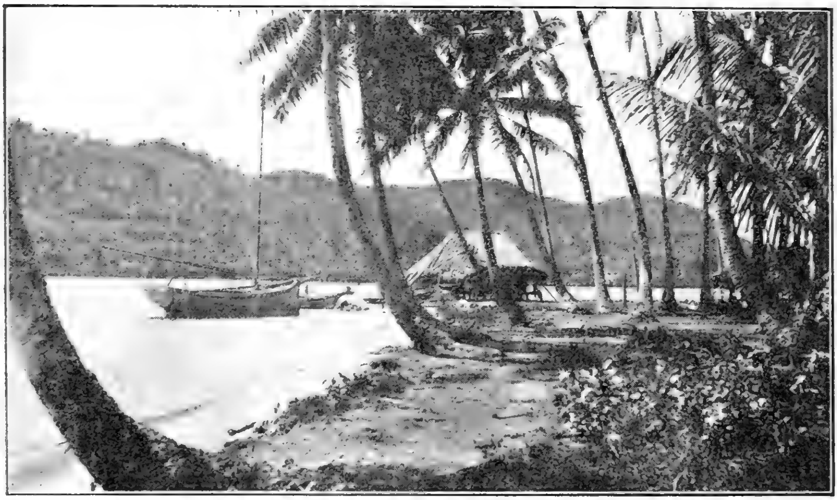

FIG. 5. ACROSS FAAROA BAY, EAST SIDE OF RAIATEA, SOCIETY ISLANDS.

reefs that it was invented to explain! A really successful theory must do much more than that: it must, in Chamberlin's phrase, explain various things that it was not invented to explain; for example, facts that were not thought to be connected with reefs, or facts that were not known when it was invented.

In order to see if a theory can stand this added test, its consequences must be logically deduced from the postulated premises and impartially confronted with the the appropriate facts. Confrontation as well as deduction demand concentration of attention on the problem in hand, and the exclusion as far as possible of all distractions, such as the remote and picturesque reef-encircled islands afford in abundance. If the confrontation is successful, the theory is good; if unsuccessful, the theory is erroneous. But why should a truism like this be stated in these modern years! Because, surprisingly enough, a review of the published studies of the coral-reef problem leads to the conclusion that, with a few distinguished exceptions and those chiefly in the works of Darwin and Dana or their followers, the methods employed have been incomplete, illogical and untrustworthy, and the results reached are therefore unconvincing.

Outgrowing Reefs on Still-standing Islands.—For example, several observers thirty-five or forty years ago came to believe that reefs are formed by outgrowth on their advancing talus around still-standing foundations. One of these observers was a zoologist of limited experience with coral reefs in the Atlantic; another, also a zoologist, had a more extended experience with coral reefs in the Pacific, but seems to have been little informed in physical geology; a third was a distinguished explorer of the oceans, who early in his scientific career came independently on this still-stand theory, as it may be called, which has become known chiefly through his vigorous advocacy of it. In an article which gave more attention to another scheme, here considered on a later page under the name of the "up- and outgrowth theory," he briefly stated his simpler theory substantially as follows:

The still-stand theory supposes that coral reefs, once established by colonizing larvæ as fringing reefs on a suitable foundation such as the shore of a young volcanic island, have been enlarged by outward growth on the advancing talus of their own detritus, the still-standing island suffering no change in attitude with respect to sea level while it is slowly worn down lower and lower as the reef grows outward; at the same time the inner part of the reef is dissolved away and converted into a shallow lagoon, so that the initial fringing reef is in time developed into a barrier reef. Finally the central island may be completely worn away, leaving an uninterrupted central lagoon, so that the barrier reef becomes an atoll. The "distinguishing feature" of this theory, as described by its inventor, is that, in conjunction with the associated theory of up- and outgrowth, by which atolls may be built up on submarine volcanoes crowned with an "organic rain" of calcareous deposits here to be discussed later, it does away with "the great and general subsidences" involved in Darwin's theory. He concluded:

> If it has been shown that atoll and barrier reefs can be formed without subsidence, then it is most unlikely that their presence in any way indicates regions of the earth's surface where there have been wide, general and slow depressions.

But why should one possibility exclude another! It is apparently true, as an abstract proposition, that coral reefs may be formed by outgrowth around still-standing islands, as this oceanographer had suggested; but a geologist asks not merely by what processes coral reefs may have been formed, but how they really have been formed. Yet because coral reefs may have been formed in a certain way, the scientific world was urged to believe that they have been formed in that way; indeed, the third inventor of this still-stand theory later rejected the possibility of reefs being formed by upgrowth during subsidence, and regarded his possible scheme of outgrowth on a still-standing foundation as the equivalent of actual processes, for he eventually said:

It seems impossible with our present knowledge to admit that atolls or barrier reefs have ever been developed after the manner indicated by Mr. Darwin's simple and beautiful theory of coral reefs.

Consequences of the Still-stand Theory.—What procedure should be followed with respect to the still-stand hypothesis by an unprejudiced inquirer? Evidently he should ask: What are all the deducible consequences of the hypothesis; which ones of these consequences can be confronted with the observable facts of to-day; and particularly which ones of the confrontable consequences are unlike the corresponding confrontable consequences of competing hypotheses. These steps are indispensable in any well ordered investigation into the past origin of existing features; and they are particularly desirable here, because they were almost wholly neglected in the statement of the theory by its leading advocate. For example, so important an element of the theory as the wearing away of the central island was very briefly treated, chiefly in a single sentence:

In the case of the atoll the cone may have been reduced below the level of the sea by the waves and atmospheric influences.

So summary a disposition of the matter is insufficient. The successive stages of this long process must be reasoned out; otherwise the theory can not be thoroughly tested. The successive stages of change must, indeed, be reasoned out with equal care and fairness for every alternative scheme, for only thereby can the investigator guard himself against becoming unwarrantably fond of some special hypothesis. He must make an effort consciously to deduce all the consequences of each hypothesis, lest an important consequence remain overlooked. He must then select those consequences which may correspond to existing facts; the others can not be used in testing the hypothesis from which they follow. And he must give special attention to those consequences of each hypothesis which contradict corresponding consequences of the rival hypotheses, because it is only in this way that crucial tests can be found which select a certain hypothesis as the successful one, and point out the others as incompetent. There is nothing whatever new about all this; the only surprising thing is that the method has not been consistently applied instead of, as a rule, unconsciously neglected in coral-reef studies.

It has been noted above that, in following the procedure thus indicated, we must often turn from coral reefs and consider various associated problems. In the case before us, we must consider the changes that a still-standing oceanic island will, while the reef is growing outward around it, suffer under the attack of subaerial erosional forces which wear its initial form down lower and lower as the reef grows larger and larger and the lagoon becomes wider and wider, till after the island reaches the form of a penultimate lowland, it is consumed by the waves

—not however by the heavy waves of the deep and open ocean, but by the moderate waves of the shallow and enclosed lagoon. To illustrate this we may assume that a young volcanic island of simple conical form and roughly circular rim is built up by eruption from the ocean bottom, and that a narrow fringing reef is established on its shore, as in sector *G* on the left side of Fig. 6. As the reef grows outward, sector *H*, on its advancing talus and a lagoon is more or less completely dissolved out behind it, the bottom of the lagoon should consist of ragged, dissolving limestone, or of insoluble residue. At the same time the central island suffers erosion; radiating valleys are excavated in its slopes and deltas are formed in the shallow lagoon, or on the inner part of the reef if it be not already dissolved away. Reefs thus formed should tend to become broad and continuous, with marks of outward growth in the form of

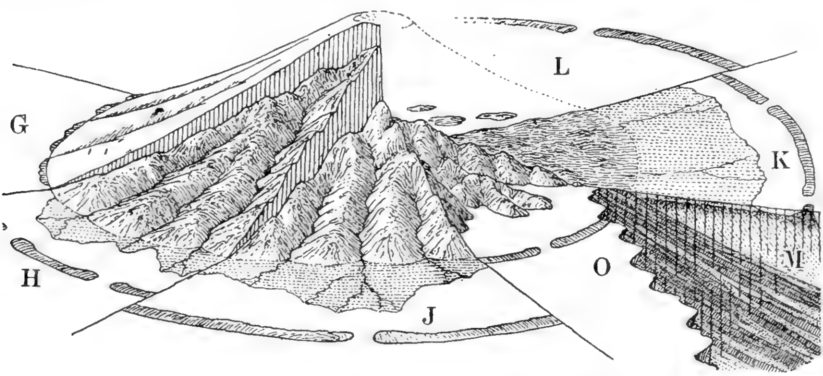

Fig. 6. Diagram of Successive Stages of Reef Formation, as deduced from the theory of outgrowing reefs on still-standing islands: sector *O*, type of actual barrier reef and its embayed central island.

prograded beach ridges; islands of coral sands should be built by the waves on the reef flats and soon become covered with vegetation. The process continues, as in sector *J*, where the volcano is much reduced in altitude while the deltas have been built forward to greater size and have become laterally confluent; and later in sector *K*, where the island is reduced to a lowland surrounded by a broad alluvial plain just above sea level; the structure of the reef is here shown in a vertical section *M*, on the side of sector *K*; the submarine talus layers must slant into deeper and deeper water at a steeper angle than the slope of the volcanic cone, the buried surface of which is not eroded, for by the conditions of the hypothesis that part of the cone has never been above sea level to suffer the attack of eroding agencies. At last in sector *L*, the lagoon waters are supposed, in a manner not clearly stated in the original account of this hypothesis, to have removed not only the alluvial delta plain but the central volcanic lowland also, except perhaps for some low residual hills; when they vanish the reef must be called an atoll; not that the

reef itself has in any way changed its nature, but that the lagoon is then uninterrupted with a depth of 10, 20 or 30 fathoms.

Confrontation of Still-Stand Consequences with Facts.—Now this is all, with the possible exception of the excavation of the atoll lagoon 20 or more fathoms deep across the volcanic lowland, easily conceivable; it may have happened, but how can we tell if it really has happened; how can we know that the hypothetical scheme, here represented graphically, truly corresponds to the history of any actual coral reefs? Only by confronting the deduced consequences of the hypothesis with the appropriate facts of observation. There is absolutely no other logical method of procedure in the coral-reef problem or in any similar problem. Where then shall we look for the appropriate facts with which the deduced consequences are to be confronted? First, in young, little dissected volcanic islands around which discontinuous fringing reefs form a narrow and incomplete girdle. Such islands are occasionally found, and thus give observational warrant for the initial conditions postulated in the still-stand hypothesis: but, as the same initial conditions are postulated in certain other hypotheses, no critical test for the correctness of the still-stand hypothesis is thus secured. We must look next at sea-level reefs of the barrier or atoll class: they confirm the possible correctness of the hypothesis, because the deduced features of barrier and atoll reefs are essentially the same as the visible features of the actual reefs—of course they are, for these sea-level reefs are the very facts which the still-stand hypothesis was invented to explain; and, if it had not explained them, it would never have been published. But the difficulty here is, that all the other hypotheses do exactly as well: they also explain the barrier and atoll reefs that they were made to explain; hence no crucial test is yet provided by means of which a choice among the competing hypotheses may be made.

What do the observable features of a lagoon within a barrier reef or atoll say, when the expected features of a lagoon as deduced from the still-stand hypothesis are confronted with them? As far as actual lagoons have been studied they contradict the idea of excavation by solution or otherwise, for they seem to be the seat of sedimentation; the sediments being supplied either by calcareous overwash from the reef, by organic deposits formed within the lagoon itself, or by outwash from the island streams. But it is to the form of the central island within a barrier reef, or to the internal structure of an elevated reef that we must give special attention, for there the consequences deduced from the hypothesis include several details that had not been observed or thought of when the hypothesis was invented; and it is the unforeseen consequences of a theory that are of special importance in testing its value. Of these two witnesses, the central island gives the most outspoken and unimpeachable testimony. Hence to the central islands of barrier reefs we will for the moment attend.

The Central Islands of Barrier Reefs.—The question now before us is: Are the features of an imagined central island, as deduced from the hypothesis here under consideration, successful counterparts of actual central islands? No, they are decidedly unsuccessful. The central islands of various barrier reefs, such as Ka-ndá-vu, Fig. 23, in the Fiji group—one of the thirty or more reef-encircled islands that I saw in 1914 in the Pacific—and various other central islands that were then seen or that have been studied before and since on large-scale charts, contradict the deduced features of the hypothetical still-standing islands in certain essential particulars. A common type of actual island is shown in sector *O*, of Fig. 6; its base line is not simple, as in sectors *G* to *K*, but elaborately embayed; and the large confluent deltas that should advance outside the simple margin of a well-dissected island, as in sector *J*, are represented only by small, separate deltas at the heads of bays and coves. Darwin long ago recognized that, in the embayed island of Vanikoro, which sector *O* represents sufficiently well, "the unusual depth of the channel [lagoon] between the shore and the reef . . . and the small quantity of low alluvial land at the foot of the mountains, all seem to show that this island has not remained long at its present level." Furthermore, inasmuch as the Pacific contains many barrier-reef islands and many more atolls, we ought, if the hypothesis under consideration be correct, to find also a good number of worn-down islands in the intermediate stage of sector *K*; but not a single example of such an island has been discovered. Again, the almost-atoll stage of sector *L* shows the small residual volcanic hills to be of low and subdued form; yet the actual form of residual volcanic hills which occupy only a small fraction of their lagoon, resembles the summits of the dissected volcano shown in sector *O*. Finally, not a single example of many elevated reefs and atolls has been described as consisting wholly of the slanting talus structure demanded by this hypothesis, as shown in section at *M*, Fig. 6. Hence, although the hypothesis explains the facts regarding the sea-level reefs that it was made to explain, it fails to explain certain other equally essential facts, and it must therefore be rejected.

What commended the Still-Stand Theory?—Thus we are led back to the conclusion that Darwin reached long ago, for in his book on "Coral Reefs," published in 1842, he considered the possibility of outgrowing reefs around still-standing islands, and, as the quotation given above shows, wisely rejected it, because the consequences to which it led were not supported by the facts. Yet in the recent history of the coral-reef problem this crude hypothesis, instead of being rejected by every one, has been cordially received by a number of eminent geologists. What can have commended it? Did its chief advocate carefully discuss various alternative hypotheses and show them to be insufficient? He may have done so privately, but he published no such discussion. Did he discuss his own theory by analyzing the associated problems and de-

ducing their consequences in systematic fashion, in order to confront the consequences with the facts and thus reach an impartial judgment? It is of course possible that he may have done so, but his published articles do not suggest that he did. Is the fundamental postulate of a still-standing island a sound one? No, for practically every oceanic island of which the history has been worked out in detail is found to have suffered some sort of change of attitude with respect to sea-level: hence the postulate of a still-standing island is probably incorrect. Can it be, perhaps, that the advocate of the still-standing hypothesis was so fully experienced in the study of coral reefs and of volcanic islands that his opinions were thereby well recommended? If we judge by the favorable consideration that has been so widely given to his hypothesis, this would appear to be the case; but alas, it was not. The advocate had been, before announcing the hypothesis, a member of an exploring expedition, which had truly enough visited several volcanic and coral islands in the Pacific and the Atlantic, but the official narrative of the expedition states that the study of coral reefs was not within its scope; hence we must suppose that the coral-reef problem was not closely attended to during the voyage.

Neglect of Essential Factors.—Nor could the literature of the coral-reef problem have been closely examined by the advocate of the still-stand theory either before or after the voyage, although the scientific world has a right to expect that it should be so examined by anyone who, discarding a generally accepted theory, proposes to replace it by a new hypothesis. Had such an examination been made, an important factor of the problem—Dana's principle of shore-line development—would have been found, clearly announced by a competent investigator and published thirty years earlier; and this factor would have prevented the acceptance of the new theory and reestablished confidence in the older theory. Indeed, if this factor had not been overlooked, the embayments of certain Pacific islands would probably have been correctly instead of incorrectly interpreted by the advocate of the still-stand theory; and he would thereby have been saved from presenting, in the report of the expedition to which he was attached, an erroneous account of the maturely dissected, reef-encircled volcanic island of Matuku, in the Fiji group, where a drowned-valley embayment on its western side is described as a crater. Had the neighboring ring-shaped volcanic island of Totoya been visited, instead of Matuku, a crater, or rather a huge caldera, of volcanic origin would truly have been found, and such a caldera does not of itself testify against still-stand, for it may have been formed by explosion or by engulfment either below or above sea-level; but to mistake the embayment of Matuku for a crater is very much as if a traveller unacquainted with the effects of tornadoes on village architecture should, on following a storm track to a ruined dwelling house, mistake its dilapidated cellar, half-filled with rain water, for its vanished attic. The chief embayment of Matuku is, like

the many smaller ones, really a valley of erosion, deeply carved below any crater that may once have existed aloft, now half drowned by subsidence and therefore occupied by sea water. Three summits rise over 1,200 feet above the bay, about two miles distant on the northeast, east, and southeast; a sounding, about as far to the west of the bay as the three summits stand on the other side, shows a depth of 400 fathoms; two miles farther west the depth is 975 fathoms.

A few pages farther on the report of the same exploring expedition announces a recent and slight elevation of a few feet in the wonderfully embayed Fiji island of Ka-ndá-vu, but says not a word of the evidence of vastly greater previous subsidence that an island of such pattern loudly proclaims. Evidently then, the problem of the sculpture of volcanic islands and the origin of their shorelines, closely associated as it is with the problem of coral reefs, had not been solved, nay, had not even been seriously studied by the advocate of the hypothesis that barrier reefs and atolls may be formed by outgrowing corals, advancing on their own talus around still-standing islands, while the lagoon is etched out by solution and the island is worn down by erosion behind them. No wonder, therefore, that his incompetent hypothesis satisfied him.

An Exceptional Island.—Is there then nothing to be said for the still-standing scheme? Yes, the island of Tahiti in the Society group has been instanced as supporting this hypothesis, for it has salient and imperfectly confluent deltas inside of its barrier reef, as the hypothesis of a still-standing island demands; but Darwin long ago recognized that such salient deltas are exceptions on barrier-reef islands, and correctly explained them as marking, not a perpetual still-stand, but a pause in subsidence. He said: "At the Society archipelago . . . the shoalness of the lagoon channels round some of the islands, the number of islets formed on the reefs of other, and the broad belt of lowland at the foot of the mountains, indicate that, although there must have been great subsidence to have produced the barrier-reefs, there has since elapsed a long stationary period"; and he adds: "This probably is the ordinary course of events, subsidence supervening after long intervals of rest." He was right, for the heads of the projecting deltas at Tahiti, Fig. 12, commonly enter a mile or more into the radial valleys back of the spur ends, precisely as they should if the island had been somewhat depressed after it was dissected, and had stood still for a time after it was depressed.

Why Was the Still-Stand Theory Accepted?—Why, then, if the hypothesis of outgrowing reefs around still-standing islands really has so little recommendation, did it ever gain so much attention? Partly, I think, because, although very briefly announced, it was stated with confident emphasis instead of with critical analysis; for confidence and emphasis go, even in science, a great way; partly also because no mention was made of certain critical facts, namely, the embayed shore-

lines of the central islands with small deltas at the bay heads, which contradict certain essential consequences of the theory, namely, non-embayed shorelines with large outstanding deltas. The readers of the article which contained this "totally new departure in coral-reef literature," as an able critic wrote, seem to have accepted it as a complete statement of the case, from which no essential facts were omitted. Indeed one of the most competent of them, everywhere recognized as a leader in geological science, championed it by saying: "We are driven to admit that barrier reefs may be formed without subsidence of the sea floor." Thus the hypothesis of outgrowing reefs around still-standing islands—a hypothesis that involves the extremely improbable fundamental postulate that oceanic islands usually stand still, a hypothesis that was constructed on an inadequate basis of incomplete observation, a hypothesis that was framed without careful study of the literature of coral reefs, a hypothesis from which all consideration of an important associated problem was omitted and from which certain essential consequences could not, therefore, be critically deduced—was announced with confident emphasis and championed with authoritative recommendation; and, as a result this incompetent hypothesis has been, especially with regard to barrier-reefs, a bar to progress for thirty years; not because it was invented, but because it was announced and accepted without sufficient study of associated problems, by means of which alone its competence could be determined.

Let me here explain briefly why so much time has been given to the consideration of an incompetent hypothesis. First, because it has been accepted by many home-students of the coral-reef problem; on that ground rather than on its merits it deserves attentive consideration. Second, because it is the duty of any investigator of a problem such as we are now discussing to examine on his own responsibility every hypothesis that has been put forward to explain it; and because it is particularly his duty to search out all the points where he has to differ from others who, just as earnestly as himself, have been striving for the truth. Finally, because it is part of his task to learn if possible the grounds which led to the acceptance by others of what is to him unacceptable. Under the actual conditions of the case thirty years ago, it was perhaps not unnatural that many home-students of coral reefs should have accepted the still-stand hypothesis; for its advocate was a man of great experience in oceanographic work, of inspiring enthusiasm, and of delightful personality; and its leading champion was a man of exceptional competence in all branches of geological science and of unusual skill in the presentation of geological problems. More important still, both of these investigators frankly avowed that they had adopted the new still-stand hypothesis because it seemed more successful in explaining coral reefs than Darwin's hypothesis of subsidence which they had previously regarded as correct, but which they had come to regard as unsuccessful. Both of them were genuinely and

sincerely devoted to scientific research; hence how could any one, who had not the time to investigate for himself the question at issue, hesitate to accept the conclusion of these two eminent experts!

It was therefore, as above said, not unnatural, under the conditions of the case thirty years ago, that the hypothesis thus proposed and guaranteed should go far toward replacing an earlier hypothesis that had till then enjoyed universal acceptance; but unhappily there is one condition of the case that, as already indicated, weakens it most seriously. Both the advocate and the champion of this hypothesis had omitted from their discussion a certain essential factor of the problem, namely the pattern of the central-island shoreline within barrier reefs; worse yet, they had, as above noted, completely overlooked a clear and conclusive statement regarding the pattern of the central islands of barrier reefs that had been published some thirty years before in easily accessible works by an earlier and highly regarded investigator of the coral-reef problem, who surely must have been known by name to both the advocate and the champion of the new hypothesis. Hence, natural as it was that the apparently complete statement of the still-stand hypothesis should have found wide acceptance, it must be given up when the previously omitted elements of the problem are found to speak uncompromisingly against it.

Veneering Reef on Wave-cut Platforms.—Let us now turn to another hypothesis: one which, without the intervention of a fringing reef, explains a barrier reef by supposing that it is a relatively thin veneer of coral limestone built on the outer edge of a platform that has been cut by sea waves around a still-standing volcanic island; and which explains atolls without the intervention of barrier reefs by supposing them to be veneers on completely truncated, still-standing volcanic islands. This hypothesis, like the one already considered, postulates still-standing volcanic islands; in view of the small thickness of its reefs it may be called the veneering hypothesis. Here the associated problem that we must consider is somewhat more complicated than before, because it includes the attack of the sea around the undefended island margin as well as that of subaerial erosion over its surface. A special sequence of forms must be produced as an island is worn away by the double attack, and the chief members of the sequence must be deduced, in order that they may be confronted with the facts. It is curious to note that here, as in the case of the previous theory, this duty has been altogether neglected. Under the double attack, a volcanic island, originally conical and undefended by any reef, will soon be cut away by the waves around its shore, like Nightingale island in the South Atlantic, well figured in the narrative volume of the *Challenger* Report, while rain and streams are furrowing its slopes: the wave-cut platform will be backed by a steep cliff, notched at the top by hanging valleys, as in sectors *H* or *J*, Fig. 7. If a veneering reef is now established on the platform edge, as at *H'* or *J'*, the retreat of the cliff,

as a cliff, will soon cease, and the hanging valleys will be cut down to sea-level; deltas will grow in front of the valleys, and a talus will gather in the quiet water at the cliff base, which was clean swept by breaking waves before. If the veneering reef is not so soon established, the platform will be cut back to a greater width and the cliff to a greater height; this stage is verified by Tristan d'Acunha, another solitary volcanic island in the South Atlantic, also figured in the *Challenger* narrative; on such becliffed islands, cascades from hanging valleys have been described, which give warrant for the hanging valley as a deduced feature of sector *J*, Fig. 9. An undefended island may be almost consumed, as in sector *K*, when only small stacks will remain; or it may be com-

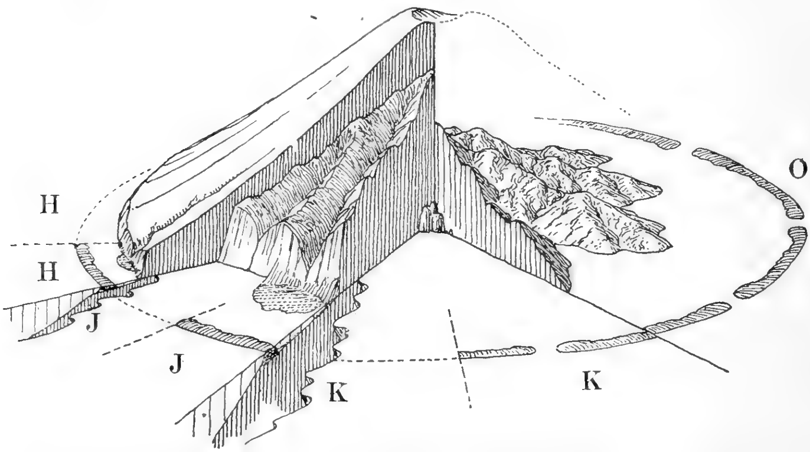

FIG. 7. DIAGRAM OF SUCCESSIVE STAGES OF REEF FORMATION, as deduced from the theory of veneering reefs on wave-cut platforms: sector *O*, type of actual barrier reef and its embayed central island.

pletely truncated before a reef is established, and then the reef will form an atoll.

Unsuccessful Consequences of the Veneering Theory.—Are the consequences of this theory, here graphically presented, confirmed when they are confronted with the facts of actual coral reefs and their associated islands? No, decidedly not. As before, the central islands of barrier reefs are again the most important independent witnesses put forth by the facts. Such islands are not cliffed around a non-embayed shoreline; they are, with hardly an exception, embayed between non-cliffed spurs, as in sector *O*, Fig. 7, or in Fig. 3. Furthermore, as there are many atolls in the ocean there should be also, if the veneering hypothesis were true, many almost finished atoll platforms; that is, many wave-swept platforms not yet enclosed by veneering reefs, with a becliffed island remnant rising from the center; but no such becliffed island remnants in the center of a wave-swept rock platform are known except on the borders or outside of the coral-reef zone. Again, there are no known examples of elevated reefs possessing the structure here demanded; elevated reefs are often hundreds of feet in thickness, and

in no case are they reported to lie on broad wave-cut platforms. Finally, this hypothesis is defective in that it furnishes no reason for the postponement of reef establishment while the platform is suffering preliminary abrasion, or for the early establishment of a veneering reef on a narrow wave-cut platform, or for the long delay before the establishment of a reef on a broad one. As a matter of observation, fringing reefs are occasionally found on young volcanic islands around which no cliff-bordered platform has been abraded, and after such reefs are formed, the waves can no longer attack the island back of the reef and cut platforms on it.

Is the hypothesis of veneering reefs perhaps recommended by any special expertness of its advocates? No. The first observers to advocate it were two missionaries, about eighty years ago. Did they deduce the essential consequences of the hypothesis, somewhat as above, and confront them impartially with the facts? No: they left that for Darwin to do a few years later; and when he showed that the central islands of barrier reefs have no such cliffs as the hypothesis demands, it was properly enough set aside in favor of his hypothesis of intermittent subsidence. But it was revived about fifty years later, this time by a surgeon of the British navy who had spent some years on certain islands of the coral zone but who was unfortunately untrained in physical geology; and again by a hydrographer, expert in marine surveying but apparently not practised in making critical choice among competing hypotheses; and by a zoologist and oceanographer of great experience, but in his case also without careful deduction of the becliffed consequences, and without any mention of the good and sufficient reasons that led Darwin to reject the hypothesis sixty years earlier. Did these later advocates of the veneering hypothesis give reasons for rejecting other hypotheses and preferring their own? It must be supposed that they thought they did, but their reasons are not convincing.

Insufficient Consideration of Possible Alternatives.—For example, one of them said: "I will pass over the theory of subsidence, supported though it was by Dana, Couthouy and Beete Jukes, because the recent facts concerning the ocean depths and the regions of living and upraised reefs compel us to regard it as no longer necessary"; that is, of two alternatives, he rejected one because its postulated subsidence was made no longer "necessary" by the possible correctness of the other; but he did not apply any impartial and crucial test as a means of making a logical choice between the two. Again the same investigator said:

> The more gradual the land-slope, the broader will be the submarine ledge [platform] cut out in the course of ages by the action of the sea, and the more distant will be the barrier-reef, that has grown up along its margin [as in Fig. 8]. This I believe to be the true explanation of the position of barrier reefs.

Yet is it not immediately manifest that the same relation will obtain

in upgrowing reefs during subsidence, as Fig. 9 shows; and is it not further manifest that if this relation is produced by subsidence, it must be associated with an embayed central island, like the unsymmetrical

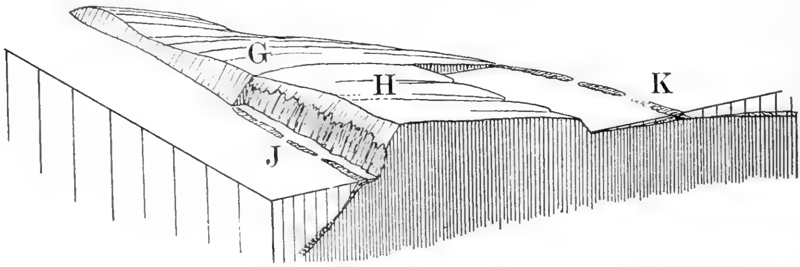

FIG. 8. DIAGRAM OF AN UNSYMMETRICAL ISLAND, *G*, on both sides of which, *H*, shallow platforms are cut by waves, and reefs, *J*, *K*, are formed.

fault-block island of Wakaya in central Fiji, as in the foreground of Fig. 10; while if it is produced by wave-cutting it must be associated with a cliff-rimmed, but not embayed central island, Fig 8, the like of which does not exist in the coral seas! Furthermore, there are well-known examples of central islands that have symmetrical slopes, but that stand to one side—sometimes to windward—of the lagoon center; witness, as in the background of Fig. 10, the island of Makongai, not far from Wakaya, both enclosed in a figure-8 barrier reef; or the

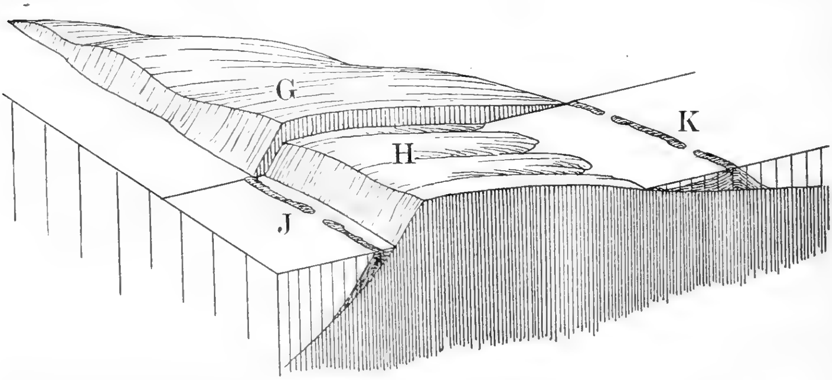

FIG. 9. DIAGRAM OF AN UNSYMMETRICAL ISLAND, *G*, which subsides, *H*, as reefs, *J*, *K*, grow upward alongside of it.

island of Mbengha, farther southwest in the Fiji group; these eccentrically placed residual islands are the natural result of the submergence of an unsymmetrical initial island, such as might have been composed of several unequal volcanoes welded into a single mass; and as they both have embayed but not becliffed shore lines, they must have been diminished by submergence; not by abrasion.

In view of such examples as these, all of which have long been charted, why should the author above quoted reject the possibility of submergence and accept the possibility of abrasion as a matter of

opinion or preference, instead of submitting both possibilities to some impartial and adequate tests, such as the presence of cliffs or of embayments so readily provides? The only answer is that he saw no necessity of looking for an impartial test; in other words, that his method

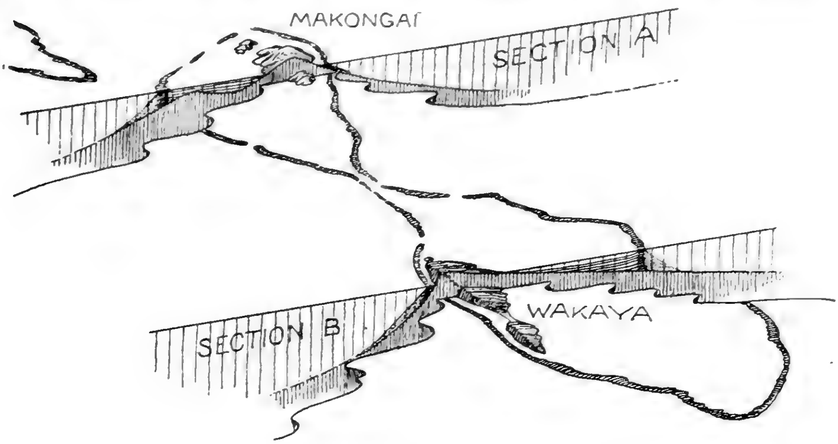

FIG. 10. BLOCK DIAGRAM OF WAKAYA, a tilted and slightly dissected fault block, and MAKONGAI, a maturely dissected volcanic mass, in the Fiji group; the two islands are enclosed in a double-looped barrier reef. Vertical sections, *A* and *B*, are drawn through the islands to show the inferred submarine relations of island to reef.

of scientific investigation was not the same as the one here adopted. He seems to have been satisfied because his theory explained the things that it was invented to explain; he asked nothing more of it! Not only so, some of his readers also were satisfied, and spoke of his essay with high praise: hence we must suppose that they too were ready to accept a theory that merely explained the things that it was invented to explain, instead of suspending their judgment until the theory should be shown competent to explain also certain other things that it had not been invented to explain. It is cases of this kind, which give warrant to the statement made on an earlier page, that in many pub-

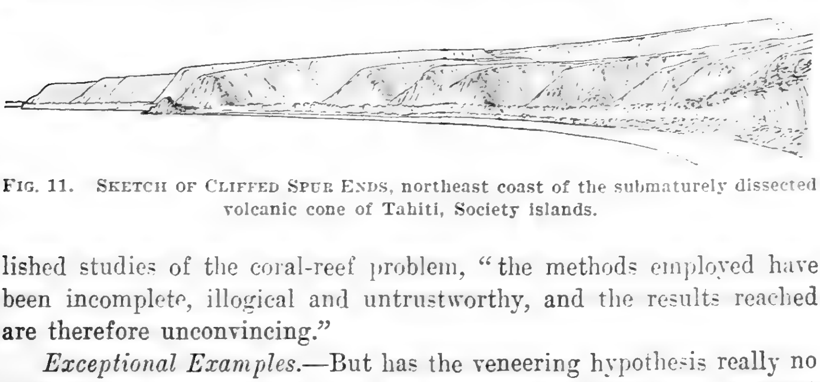

FIG. 11. SKETCH OF CLIFFED SPUR ENDS, northeast coast of the submaturely dissected volcanic cone of Tahiti, Society islands.

lished studies of the coral-reef problem, "the methods employed have been incomplete, illogical and untrustworthy, and the results reached are therefore unconvincing."

Exceptional Examples.—But has the veneering hypothesis really no independent support? Yes, in two exceptional examples the central islands of barrier reefs are cliffed around part of their margin: one is

Tahiti, Fig. 11, but there, as above intimated, it may be shown that the spur-end cliffs as well as the inter-spur valleys were cut when the island stood higher than now, and that since then the island has been submerged, for its valleys between the truncated spur ends are occupied either by arms of the sea or, more generally, by the heads of delta plains, as in Fig. 12. The other example is New Caledonia, which is strongly cliffed at its southeastern end and along part of the northeastern side; but as at Tahiti, these cliffs, as well as the numerous valleys of this long island, were cut when the island stood higher, and the

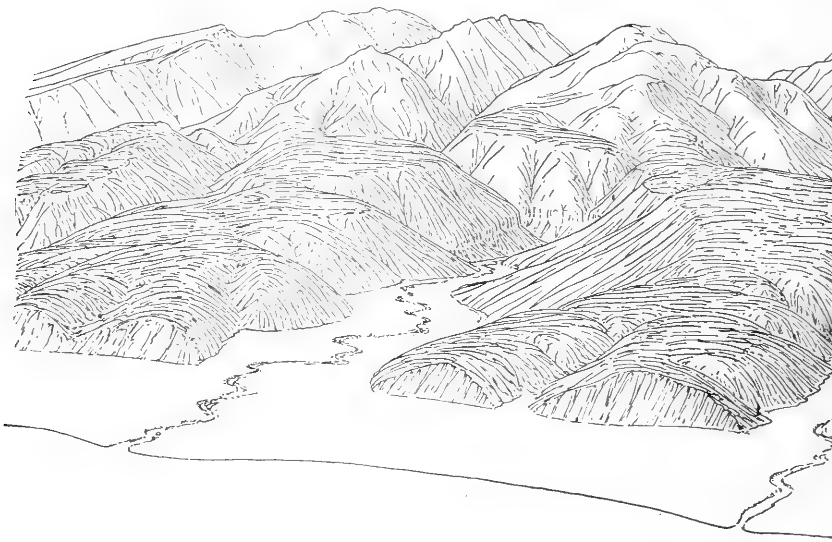

FIG. 12. BIRD'S-EYE DIAGRAM OF NORTHERN COAST, TAHITI, showing cliffed spur ends, separated by delta-filled embayments and prograded by a half-mile alluvial plain. The plain is for the most part covered with palm trees. Papeete, the capitol, lies on the plain to the left of the diagram.

same submergence that has embayed the valleys has half-drowned the cliffs. Hence, the two best examples of becliffed islands, though peculiar in possessing cliffs, are not peculiar also in having stood still, for both have suffered submergence. These islands are truly of great interest and merit special study; but they are as truly exceptions in the long list of reef-encircled islands, in which the spurs that separate the embayments as a rule taper down gradually, and dip below the sea with nothing more than little nips or low bluffs cut by the lagoon waves close to present sea-level. The great majority of volcanic islands are not cliffed at all in the way the hypothesis of veneering barrier reefs and atolls demands, and for them the hypothesis must be rejected completely. Yet this hypothesis was presented with so convinced an emphasis by its above-quoted advocate, that an eminent geologist thereupon wrote:

I have read Dr. ——————'s paper with great interest, and am of opinion that he has made out a very strong case indeed against the theory of

coral island formation advanced by Mr. Darwin. . . . The famous Darwinian theory of coral reefs can no longer be said to hold the field.

Another critic said that, if the facts and arguments here adduced had been known to Darwin,

the great naturalist would have accepted the explanation of the phenomena now formulated, and would have given up his ingenious theory of gradual elevations and subsidences of the sea bottom.

A third critic wrote, in view of the still-stand and the veneering theories:

It is somewhat surprising that, in the discussion which has lately [1883–1888] been carried on in the English reviews . . . regarding the new theory of coral reefs, no one should have dwelt upon the fact, that, with the exception of Dana, Jukes, and others who published their results on coral reefs soon after Darwin's theory took the scientific world by storm, not a single recent investigator of coral reefs has been able to accept this explanation as applicable to the special district which he has examined.

A fourth said:

A singular feature of these papers [at the British Association meeting, 1888] is the almost complete unanimity with which those authors, who have themselves practical experience of coral reefs, reject the subsidence theory as inadequate, or unnecessary.

Thus it would appear that Darwin's theory was well nigh abandoned. But none of these critics asked: Are the central islands of barrier reefs cliffed or delta-fronted, as they should be according to other hypotheses? All of which goes to show that the method of scientific investigation applicable to coral reefs is far from having been standardized; for as soon as the consequences of the hypothesis of veneering reefs are explicitly deduced and frankly confronted with the appropriate facts, the hypothesis must necessarily be given up by any independent investigator who demands that such confrontation shall be successful before he gives faith to the hypothesis that brings it forth. Yet this theory was set forth for the Great Barrier reef of Australia with such vigor by a zoological expert that another zoological expert declared the theory of subsidence to be "absolutely excluded" as an explanation for that greatest of all reefs; although the not cliffed but deeply embayed coast of Queensland presents abundant and convincing evidence that strong subsidence has taken place, as was pointed out by Penck in 1896, as has later been shown by Andrews and other Australian observers in 1902, and following years, and as I had occasion of seeing for myself along a stretch of several hundred miles in 1914.

(*To be continued*)

THE EXUDATION OF ICE FROM STEMS OF PLANTS

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I. Introduction

NOCTURNAL radiation is generally a passing of radiant energy from terrestrial substances into space. On a clear night the rate at which radiation passes outward from a lamp-black surface is very great, amounting to about one tenth of the solar constant. Of course, not all substances lose heat at this rate. This loss of heat by radiation produces peculiar formations of ice, some of which will now be mentioned.

Ground Ice or Columnar Ice.—The most familiar freak of ice formation occurs on bare, clayey soils which contain a certain minimum amount of moisture. If the moisture content of the soil falls below the minimum value (which no doubt varies for different soils) then evaporation occurs as rapidly as the moisture is brought to the surface (by capillary action) and no ice is formed. According to the writer's observations the ice is formed in contact with a nucleus which may be a grain of sand, a small pebble, etc. The earthy material has a higher emissivity than the water, it cools the more rapidly, and the water is frozen to the under side of the nucleus. As heat is lost, more ice is formed and, as it accumulates, rises in columns, as it is to be observed everywhere on cold mornings. The water is supplied by capillary movement in the soil, from the surface of which the ground ice may be readily lifted, since in freezing weather the ice is not frozen into the soil.[1] The general experience is to find the ground ice supporting a nucleus (say a grain of sand, or even large stones, $3 \times 1\frac{1}{2} \times 1$ inches in size). The nuclei may be thinly distributed. The writer has observed several large areas, $3 \times 1\frac{1}{2}$ feet which did not contain nuclei, from which it appears that this type of ice formation can occur without having a nucleus (gravel, etc.) to start the refrigeration.

Anchor Ice.—Barnes[2] has made a prolonged study of the formation of anchor ice at the bottom of the St. Lawrence river. This kind of ice consists of fine spicules which adhere to the bottom of the river. It is a friable mass which may vary from six to eight feet in thickness. According to Barnes this ice is formed as a result of the greater emis-

[1] Abbe, *Amer. Meteorological Jour.*, 9, p. 523, 1893.

[2] "Ice Formation with Special Reference to Anchor Ice and Frazil," H. T. Barnes, *Monthly Weather Review*, May, 1907, p. 225.

sivity, and hence the greater cooling of the material composing the river bottom.

Hoar Frost.—This is another example of ice formation as the result of cooling by radiation. Here, however, the accepted explanation is that the ice spicules are formed by accretion, as the result of the deposition of moisture from the surrounding air.

The foregoing are familiar and interesting illustrations of ice formations on substances as the result primarily of the loss of heat by radiation. We have now to consider a rarer phenomenon, which is the subject of the present paper.

Ice Formations on Plants.—According to the writer's observations the amount of ice formed upon a plant stem is a function of (1) the rate at which water can rise by capillary action in the sap tubes within the stem, (2) the ease with which the moisture can pass out to the surface, (3) the rate of evaporation from the surface (convection, wind-velocity) and (4) the emissivity of the surface of the stem. Instead of the title "Exudation of Ice," a more pretentious title would have been "*The Capillary Movement of Water—An Experimental Demonstration by Means of the Formation of Ice Fringes on Plants.*" This might appear more scientific and one could discuss the capillary movement of water as a function of the temperature of the stem; the size of bore and number of (sap) tubes; the thickness and permeability of the walls of these tubes, etc. However, the present communication makes no pretense at such completeness of the investigation. In fact, the subject of ice formation forced itself upon the writer at a time when other duties were pressing, and hence it could not be given the attention it deserved. As a result, the experimental tests were usually carried out only to the extent of refuting the various notions held by various persons as to the cause of this ice formation. It was shown that the formation of fringes of ice on plant stems is not the result of accretion, hydrostatic pressure, rifts in the stem, moisture in the bark, the presence of sap, etc., but that it is the result primarily of the capillary movement of water in the numerous sap tubes which are to be found in those plant stems, upon which the ice formations are the most conspicuous.

II. Historical Data

One of the earliest descriptions of the exudation of ice fringes from plants was published by Herschel,[3] about eighty years ago. His observations relate to the icy fringes which were formed around thistle stalks, and stumps of heliotropes many specimens of which were still green. Stephen Elliot[4] had previously described a remarkable protrusion of fibers of ice from the stems of flea bane (*Conyza bifrons*).

[3] Sir John Herschel, *Phil. Mag.* (3), 2, p. 110, 1833.

[4] Stephen Elliot, "Sketch of the Botany of South Carolina and Georgia," published in 1824; Vol. 2, p. 322. Quoted by Le Conte.

The fullest account, with an attempted explanation of this phenomenon, was given by John Le Conte[5] about sixty-three years ago. His observations are on two species of flea bane, *Pluchea bifrons,* and *Pluchea camphorata,* which he found growing in wet soils, around ponds and along roadside ditches in the lowlands of South Carolina and Georgia. In these plants the root is perennial, but the stem is annual and herbaceous.

Le Conte's descriptions differ materially from my own. His observations appeared to establish the following facts in relation to the phenomenon.

1. The depositions of ice are entirely confined to the immediate neighborhood of the roots of the plants, the upper parts of the tall unbroken stalks being quite free from them. They frequently commence two or three inches from the ground, and extend from three to four inches along the axis of the stem. The stalks are dead, and quite dry to within about six inches of the earth, below which they are generally green and succulent. The plant has a large and porous pith, which is always saturated with moisture, as high as six or seven inches from the base of the stem. From this it would appear that the ice was formed on the green stems, as was true of many of the specimens of heliotrope described by Herschel.

2. The ice emanates in a kind of riband, or frill-shaped, wavy, friable, semipellucid excrescence,

the structure of which (quoting Herschel) "is fibrous like that of the fibrous variety of gypsum, presenting a glassy silky wavy surface; the direction of the fibers being at right angles to the stem or horizontal." Le Conte found that the number of ribands varied from one to five, which issued from the stems in vertical or longitudinal lines, often unsymmetrically displaced around the axis. He frequently observed the icy excrescences to exceed five inches in length; often curled back so that the remote extremity of the frill came close to the line of attachment to the stalk.

From this it may be noticed that the amount of ice formed is very considerable. Evidently the moisture must come from within the plant. The amount of water congealed during a single night is vastly too great to come from the aqueous vapor in the atmosphere, hence the phenomenon can not be a modification of hoar-frost. In fact, in the illustrations to be cited presently, which were observed by the writer, the excrescences of ice on one particular species of plant were formed every night which was sufficiently cool for ice formation, although there was little or no formation of hoar frost anywhere in the vicinity.

3. Although the ice sheets appeared to protrude from the interior of the stem, both Herschel and Le Conte found that usually the stems were solid and that the ice terminated at the surface.

The point of attachment of the ice was always the wood, beneath the outer bark or epidermis, which the frozen sheets had in every instance stripped off, and forced out to a distance.

[5] John Le Conte, *Proc. Amer. Assoc. Adv. Sci.,* Vol. 3, p. 20, 1850.

When the frost was severe, Le Conte found that the ice riband was continuous with the frozen pith, through a longitudinal rift in the woody stem.

4. Le Conte found that

> the phenomenon took place in the same plant during several consecutive nights; and when the wood was not rifted, frequently from the same portion of the stalk. When the wood was split, however, the deposition of ice occurred lower down the stem, at a part which was unaffected by the frost of the previous night. The stalks thus became completely rifted by a succession of severe nights, from the height of six or seven inches down to the ground. This is unquestionably one of the reasons why these exudations of ice are seldom observed after the middle of the winter, for the stalks are usually destroyed before this period.

Ward[6] has given a rather popular description of the occurrence of ice fringes. He describes the fringes as projecting out horizontally, "not straight and stiff, but gently and gracefully curving or coiling into a beautiful conch-like roll at the distal end." His observations were probably of short duration, otherwise he would have found but few instances in which the "fringes are attached at regular intervals around the stem, like paddles of a turbine wheel." He found that the bark was split into strips at the zone occupied by the ice-sheets. He concluded that the ice had passed through these rifts in the bark. He thought that the water might have been pressed or drawn up through the cambium layer. He wisely dismisses the explanation because it "explained too much, since no reason can be assigned why the phenomenon should not be universal and not confined to one species."[7] In the present paper the micro-photographs of the cross-sections of various plants will assign this reason, viz., the difference in the porosity of the stems.

Le Conte considered the ice formation on plants to be a physical phenomenon, having no connection with the vitality of the stem. His explanation of the formation was that the moisture from the pith passes out along the wedge-shaped medullary rays, which are to be found in abundance in this plant, and is frozen on the outside of the stem. He considered that the wedge-shaped medullary rays exerted a "projectile force" which brings the moisture to the surface. The exudation of ice columns from the earth he referred to the same cause, viz., a rapid and forcible expansion along capillary tubes.

To the writer it does not appear necessary to postulate a complex "projectile force" to explain the ice fringes on plants. In fact, the plants upon which ice is formed in the great abundance have a preponderance of sap tubes, only an insignificant part of the stem being occupied by medullary rays.

[6] Ward, *Botanical Gazette,* 18, p. 183, 1893, "Frost Freaks of the Dittany."

[7] Ward quotes Gray's Manual, 1848, in which *Helianthemum canadense* is described as behaving in a similar way.

III. Recent Data

The present observations are on *Cunila mariana,* or Dittany, the stem of which is a herbaceous annual with perennial roots. This plant seems to thrive on dry ground, even on bare hillsides exposed to the blazing sun, where there is nothing but gravel and a few "asters." Other samples were found under trees where either the shade or the gravelly character of the soil prevented a luxuriant growth of other plants. The finest samples were found on a hillside which contained plenty of moisture, which was free from trees, but contained shrubbery.

The first observations were made on a frosty morning in November, 1913. The first example, because of its white ribbony character, was passed by, thinking it was something thrown from a passing carriage. The conspicuous fibrous white loops and ribbons drew my attention, and it was at once observed that they occurred upon only one species of herbaceous plant.

Owing to the pressure of other problems requiring close attention, the tendency at the very first was to dismiss the subject by accepting Le Conte's explanation that the moisture comes from the pith. This explanation was at once disproved, however, by the observations on the splinters of the *Cunila* stem, which formed ice always on the outside of the stem, but never on the pith. This, of course, should be expected, for pith is composed of small hexahedral cells along which water can not pass by capillary attraction, and it would be very unlikely that it would be transferred by soaking through the cell walls.

It was concluded that the moisture for producing the ice fringe came from the sap tubes and experiments were devised to prove this assumption. Photographs were taken of thin sections across the stems of heliotrope, thistle and also of an aster which was found near a *Cunila* stalk. The object in giving these photo-micrographs (which were very kindly prepared by Mr. E. D. Tillyer) is to show typical examples which have but few sap tubes and which form but little or no ice; also typical examples of plants which have numerous sap tubes and which form an abundance of ice fringes.

The aster is typical of plants having but few sap tubes. As shown in Fig. 1, the woody structure is very compact, with but few sap tubes. All these photo-microsections are magnified fifty times, from which one can obtain some idea of the great difference in porosity of the different plants.

On only one occasion was ice observed upon the stem of the aster. The ice was a small "tooth" formed close to the ground. From the section shown in Fig. 1 it is evident that the structure of the wood fiber is so close that the moisture which is drawn up within the stem by capillary attraction can reach the surface of the stem at only a very slow rate. Hence the moisture disappears by evaporation as rapidly as it comes to the surface. The thistle (Fig. 2) and the heliotrope

(Fig. 3) stems have numerous large sap tubes. In the thistle stem there is a row of large tubes situated near the bark. The presence of

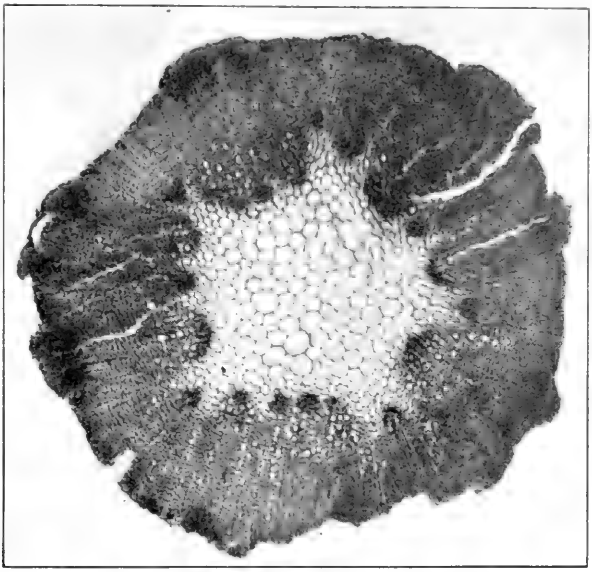

FIG. 1. PHOTOMICROGRAPH OF A CROSS SECTION OF THE STEM OF AN ASTER. It is typical of plants having but few sap tubes, and forming no ice fringes.

these large tubes filled with sap may explain the formation of ice fringes, as observed by Herschel.

A photo-micrograph of a thin section of *Cunila* is shown in Fig. 4. The numerous holes in the wood are the "sap tubes," which form an easy path for the moisture to rise within the stem, by capillary attrac-

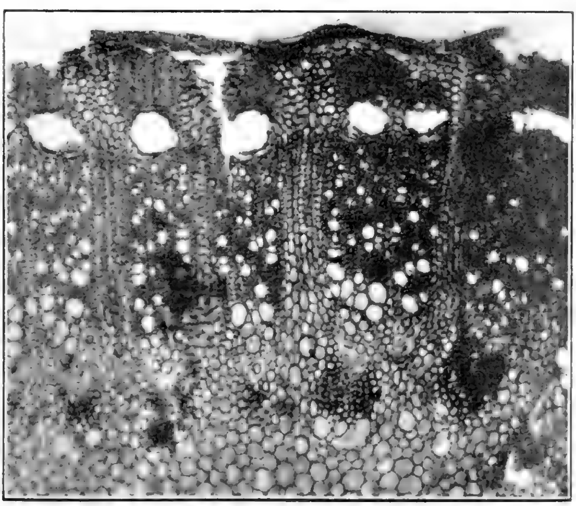

FIG. 2. PHOTOMICROGRAPH OF A SECTION OF THE STEM OF A THISTLE, showing numerous sap tubes.

tion. It would be interesting to determine to what extent this capillary movement of water is affected by the temperature of the surroundings.

The explanation of the formation of ice fringes, which are found to occur so abundantly upon the stems of the *Cunila,* and which are not found upon other plants, is based upon the presence of a great

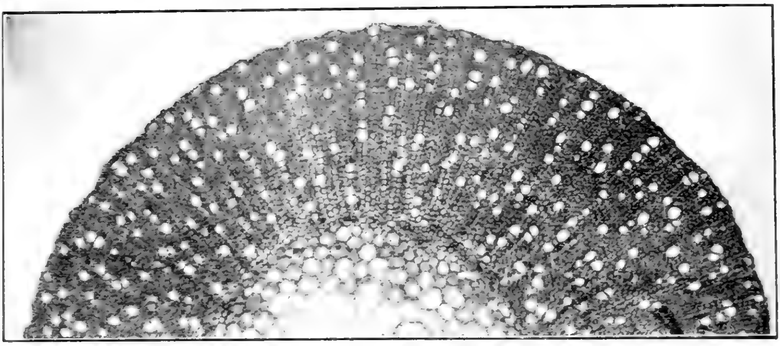

FIG. 3. PHOTOMICROGRAPH OF A CROSS SECTION OF THE STEM OF HELIOTROPE, showing numerous but widely separated sap tubes.

number of closely adjoining sap tubes within the stem of the *Cunila.* But even the very woody portion of the base of the *Cunila* stem was found to be inactive in the formation of ice fringes.

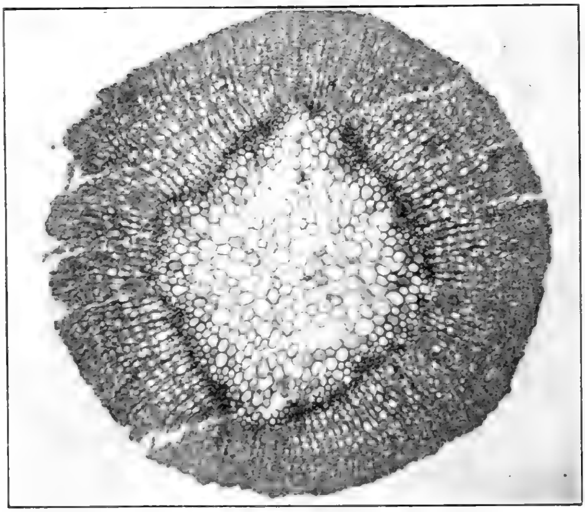

FIG. 4. PHOTOMICROGRAPH OF A CROSS SECTION OF THE STEM OF *Cunila mariana.* It is typical of plants having an abundance of sap tubes which transfer moisture to the surface by capillary attraction of the water in the soil.

It was found that the ice fringes rarely start from the side of the stem where the pith is closest to the bark. This eliminates to some extent the question whether the pith is instrumental in forming the ice

fringes. In the splinters (and in the rifted stems) of *Cunila* at no time was ice found to have formed along the line of separation of the stem. This seemed puzzling at first, for it appeared to contradict the idea that the moisture comes from the sap tubes within the stem; in which case one would expect to find the formation of ice fringes facilitated upon the surface laid bare by splitting. The microsections of the *Cunila* stems show in a very unexpected manner why no ice-fringes are formed upon the rifted surface of the stem. As already stated, the rift always occurs at the "corners" of the pith where the woody part of the stem is the thinnest. In Fig. 4 it may be noticed that at these four points, where the wood is the thinnest, there are but few, if any, sap tubes. Hence one need not expect, as a rule, to find ice formations upon the surfaces formed by splitting.

IV. Observations showing how the Ice Fringe grows

One of the most interesting observations was on the formation of the ice fringe from its very beginning. This was witnessed by several of my colleagues who were called in to verify the observations. On a cold morning, February 16, 1913, several stems, placed in water, were exposed outside the laboratory window, and in about 20 minutes the ice fringe was observed to be forming. It consisted of a row of fine hairs extending up and down over a length of about 4 mm. of the stem, and projecting out horizontally 0.2 to 0.3 mm., as shown in Fig 5, *a*. These filaments were visible only when viewed against sky light, and they melted immediately on lifting the glass cover. The fringe did not appear to form at the line where the pith is closest to the surface of the stem. The experiment was repeated again during the evening. Within half an hour after placing the samples in the cold air one stem showed several fringes in the form of thin transparent "teeth," each one being about 12 mm. in length and about 1 mm. in height. Another stem showed a fine hairy fringe which was visible when viewed against a gaslight. Within half an hour this hairy fringe appeared to be solid with some of the fine hairs extending horizontally outward through the solid "tooth" of ice, as shown in Fig. 5, *b*. This, of course, is the general structure of the fringes. By the next morning numerous wide fringes had formed on these stems. In another sample, the tooth of ice pushed out a narrow strip of bark. In these tests the receptacle containing the water was small, and hence the whole cooled very rapidly and the water froze, which prevented the growth of the ice fringes. It is to be noticed that the ice fringe forms some distance up the stem at a point where it cools the quickest and where the moisture has risen to about its maximum height. The experiment was repeated ("Test *C*," which was started February 17, contained half a dozen samples of *Cunila* and a stem of an "aster") using a large test tube. The test tube was imbedded in wool to retard cooling and

freezing. Within 15 minutes after placing this test outside of the laboratory window two small fringes, 1.5 mm. long and about 0.3 mm. high, were noticed when viewed against sky light. This test was prolonged for some days and nights and a photograph was taken (February 18, 1913) (Fig. 6) showing that the stems in water form ice just as they do when attached to the roots. In this photograph, which is magnified slightly (1.2) about one third of the upper part of the largest fringe is broken off. These fringes appear to be a little more transparent than those found in the field, owing to the fact that they had begun to melt while taking the photograph. No ice or moisture was formed upon the aster stem, which is in agreement with the field observations.

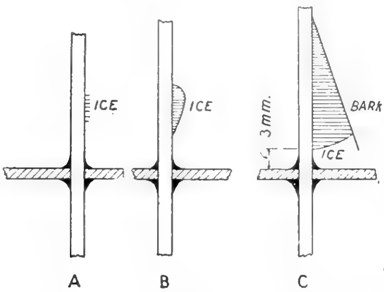

FIG. 5. ILLUSTRATING SUCCESSIVE STAGES IN THE GROWTH OF THE ICE FRINGE on the stem of *Cunila mariana* when placed in water and exposed to a freezing atmosphere.

As may be seen from Fig. 4, the *Cunila* stem on drying (shrinking) splits easily into four parts, owing to the small amount of wood fiber at the four "sides" of the stem. One of the samples used in "Test *C*" was a splinter, consisting of one quarter of the stem, about 6 cm. in length, with a line of pith adhering to the inner side. On the following morning, and on subsequent days, this splinter showed a fringe of ice on the woody surface, but at no time was there ice formed on the pith. An interesting feature (which to the writer became a common observation) was that the ice fringe did not always start at the "corner" of the stem where the wood is thinnest, but at a mid-point (see Fig. 4). From the photo-micrograph of a thin section of the stem (Fig. 4) it appears that the largest part of the ice fringe may form at the point where the sap tubes lie nearest the surface, hence where the moisture can be supplied the most easily.

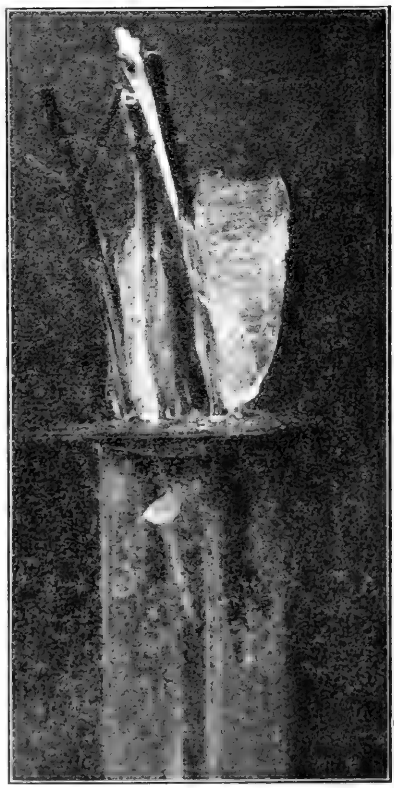
FIG. 6. SHOWING ICE FRINGES FROZEN UPON STEMS OF *Cunila mariana* which were in a test tube containing water.

The ease with which these stems became saturated with water after having been drying for weeks is another item worth noticing. All the stems used in "Tests *C* and *D*" (Fig. 6 is Test *C*) had been in the laboratory for some time. Some of them had been gathered in November, 1913, and had been freed of bark by previous ice formations.

It is generally supposed that the ice is formed more easily in the fall (when the plants are fresh) than in the late winter. This seems to be true to some extent according to my field observations and to my laboratory tests. In the latter the ice did not seem to form so abundantly after the stems had soaked for some weeks. It seemed as though the sap tubes became clogged or the plant had begun to decay.

V. Description of Photographs of Ice Fringes

The attempts at photographing the ice fringes as they occurred in the woods were far from satisfactory. This was owing to the fact that at 8 A.M. the illumination was low. A wide stop was used in the camera and consequently the objects are in focus only in the center of the photograph. They serve the purpose, however, to illustrate their general appearance as found in the woods. The ice fringes are generally viewed at an angle at about 45° with the ground.

The photographs in Fig. 7 were obtained in January, 1915. They are typical of what one finds as regards size and general appearance of the ice fringes. The fringe in the lower right-hand corner is composed of three whorls. The open space in the fringe is shown by the round dark spot in the center. The photographs shown in Fig. 8 were obtained in the middle of January, 1915. The ice formation on the stalk in the lower left-hand corner of the photograph contains two beautifully folded fringes, the markings of which are unfortunately lost in the print.

The finest photographs were obtained by collecting a number of ice fringes one cold frosty morning (January 6, 1914) and having them photographed at the Bureau of Standards. Grateful acknowledgment is due Mr. E. D. Tillyer for his painstaking care in making these photographs, which no doubt are the finest records yet obtained of these beautiful ice formations.

In Fig. 9 the four most conspicuous ice fringes are lettered *a, b, c, d,* which makes identification easy in Figs. 10 and 11. In these illustrations the ice fringes were photographed from different sides. In Fig. 9, *a,* it may be noticed that the stem is free from bark. In Figs. 9 and 10 an extremely thin delicate fringe may be noticed protruding from what appears to be a rift in the stem, but what in reality is a piece of bark. It is an excellent illustration of the second stage in the formation of the ice fringe, as described on a preceding page and illustrated

in Fig. 5, *b*. In Fig. 10 the oft-mentioned, thin, wedge-shaped fringe (see Fig. 9) is shown to advantage, protruding (upwards in the photograph) from above the large fringes. The *Cunila* stalk (Figs. 10 and 11) shown in these plates is typical of what one finds after several ice formations, when the stem is well stripped of bark. The stem is 2.2 mm. in diameter and it is not rifted. As shown in Fig. 10, the "width" of the fringe adhering to the stem is 3 cm. It extends out horizontally 3 cm. from the stem. The distance from the stem to the extreme distal end of the loop is 4 cm. The weight of the ice formation is over 5 grams.

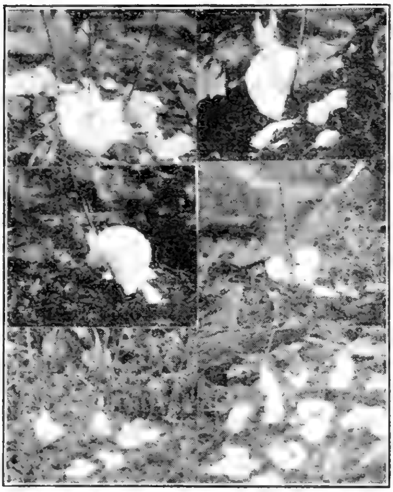

FIG. 7. A COLLECTION OF 6 PHOTOGRAPHS SHOWING VARIOUS FORMATIONS OF ICE FRINGES ON *Cunila*.

Fig. 9, *b*, consists of three splinters, united at the base of the stem. They are, of course, the remnants of the stalk which had long since disappeared. The dark line in the wood is the pith, which is shown to better advantage in Fig. 11. In Figs. 9, *d*, and 11, *b*, the pith-side of the splinters is shown to advantage. We thus have a photographic record of the ice formation, not only upon the unrifted stalk, Fig. 9, *a*, but also of the formation on the rifted stalk, Fig. 9, *c*, and of the formation upon the bare splinters, Fig. 9, *b* and *d*. The fringe in Fig. 9, *b*, is an unusually interesting ice formation. The peculiar whorl in the center is the meeting point of two fringes (see Fig. 12) both of which began curving clockwise. The extreme thinness and the great transparency is to be noticed by the light and the dark streaks through the fringes in Fig. 9, *d*.

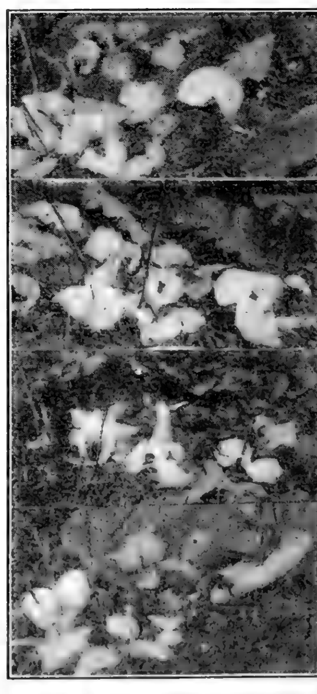

FIG. 8. SHOWING A COLLECTION OF FOUR PHOTOGRAPHS OF ICE FRINGES ON *Cunila*.

The small ice fringes on the stalk shown in Figs. 9, *c*, and 11, *c*, are of interest because they occur upon a thin stem which is split into two parts, the rift being easily distinguished in the photographs. In fact, most of the rift is above the ice fringes. This ice formation is also conspicuous in having pushed out some of the bark as illustrated in Fig. 5, *c*. This is an excel-

lent photographic record showing that the ice is not formed upon the pith (Fig. 9, *b*) or in the rift of the *Cunila* stem.

Figs. 9, *d* and 11, *d*, give a further illustration of the formation of ice fringes upon fragments of stems of the *Cunila*. The sample is a very small one. The stump of the stalk had to be cut out of the ground

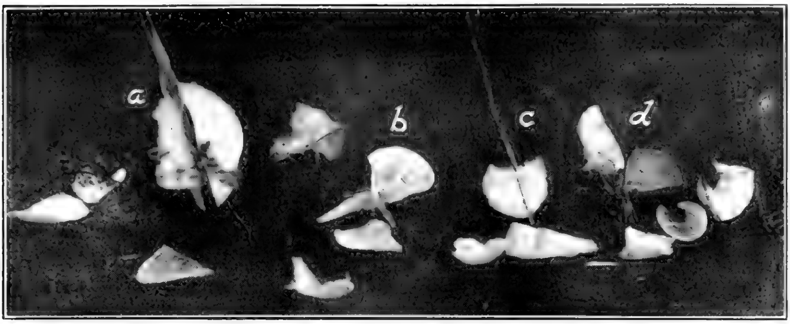

FIG. 9. PHOTOGRAPHS OF ICE FRINGES ON *Cunila mariana*.

in order to obtain the fringes. Some of the ground is still adhering to the stem. One of the fringes is broken off. The extremely thin translucent fringe (it appears to be dark, owing to the dark background) on the right-hand side of Fig. 9, *d*, is an excellent photographic record of the manner of growth of the ice fringe—as described on a previous

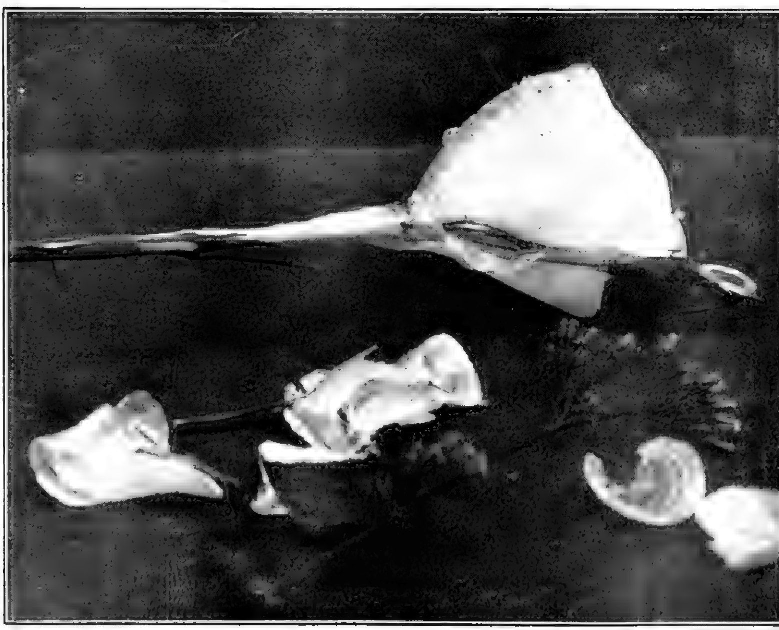

FIG. 10. ENLARGED VIEW OF ICE FRINGES ON *Cunila*.

page. The growth of the fringe is along a straight edge which appears almost horizontal in the photograph. This, however, is partly owing to the peculiar curvature of the fringe. The distal edge is straight and

FIG. 11. ENLARGED VIEW OF ICE FRINGES ON *Cunila*.

smooth, just as it started when near the stem. The photographic record is therefore an excellent contradiction of the hoar-frost theory of accumulation in which the ice is formed in spicules. The dark streak

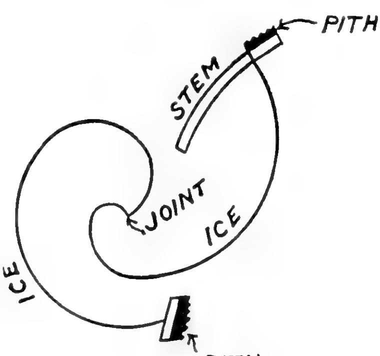

FIG. 12. ILLUSTRATING THE PECULIAR GROWTH OF THE ICE FRINGE SHOWN IN FIGS. 9 AND 11*b*.

along the fragment of stem is pith. The ice fringe is upon the woody side of the stem. In Fig. 12 is given a diagrammatic illustration of the whorled fringe shown in Figs. 9 and 11, *b*. All the plates show

fragments of ice fringes, the bright and dark streaks of which are owing to the difference in thickness and transparency of the ice. Fig. 6 mentioned elsewhere is a photographic record of the laboratory. It was

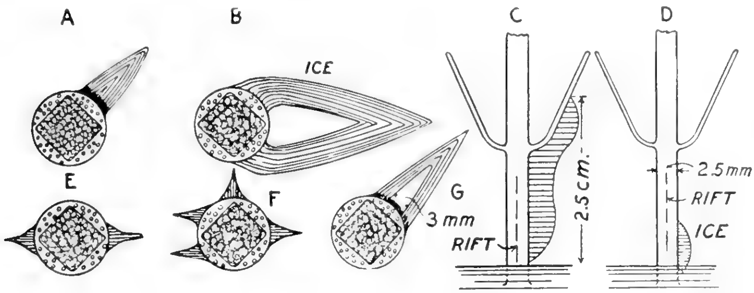

FIG. 13. ILLUSTRATING THE BEGINNING OF THE ICE-FORMATION AS OBSERVED IN THE FIELD AND IN THE LABORATORY.

taken by the writer Feb. 18, 1914. The test-tube was about 20 mm. in diameter, which gives one some idea of the dimensions. The test is described on a preceding page. This record is of interest mainly in showing that the *Cunila* stems after having been in the laboratory for some months form ice fringes just as they do when attached to the roots. In Figs. 13 and 14 are given illustrations of the growth of ice fringes

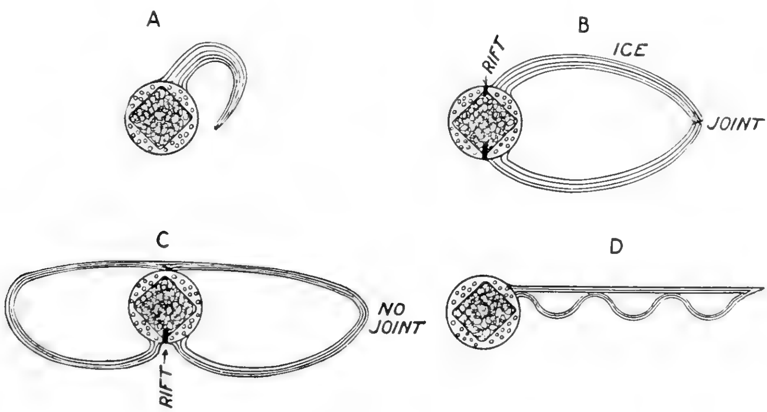

FIG. 14. ILLUSTRATING LATER STAGES IN THE FORMATION OF ICE FRINGES AS OBSERVED IN THE FIELD.

as observed in the field and in the laboratory. They are self-explanatory, and while it is true that they are diagrammatic, they nevertheless illustrate the complex and diversified manner in which the fringes occur. It seems needless to say that they are reproduced from sketches made at the time of observation.

VI. Summary.

This paper deals with the formation of ice fringes upon the Dittany, *Cunila mariana*. The data presented are based upon experiments and observations, in the field and in the laboratory.

It was observed that the ice fringes are formed when the temperature falls to freezing (0° C., 32° F.); but they are not a function of the hoar-frost which may be present upon the ground.

The ice fringes do not form upon the side of a splinter which contains the pith or upon the line of fracture, but upon the outer woody surface. The formation of the ice fringe, however, is not a function of the surface condition of the stem. The stem is frequently found to be cracked, but usually no ice protrudes from the rifts.

The growth of the ice fringe ceases when the ground is frozen to a depth of 2 to 3 cm., and when the moisture in the stem is frozen.

The size of the ice fringes and the height to which they extend above the ground depend upon the rate of evaporation from the stem, and upon the amount of moisture in the ground. Over 5 grams of ice may be formed upon a single plant during a single night.

Photographs are given of ice fringes formed upon stems which had been kept in the laboratory several months. They show that the ice may be formed upon stems without the roots. Hence the ice is not formed as a result of hydrostatic pressure exerted by the roots which are perennial.

All the observations are in agreement in showing that the moisture rises in the stem as the result of capillary attraction. The height (1 to 5 cm.) to which the moisture can rise within the stem is governed partly by the rate of evaporation from the surface. Photomicrographs of thin sections of plants are given, which show the structure of stems of plants which do not form ice fringes; also photomicrographs of sections of stems of plants which form ice fringes. It is shown that those plants which form ice fringes the most readily and in the greatest abundance have the most sap tubes.

The ice fringe is a composite of a number of very thin ribbons. In the laboratory the formation of the ice fringe was observed from its very beginning. The first stage in the production of the ice fringe consists of a single row of fine hair-like filaments of ice. This row of ice filaments lengthens up and down the stem. The filaments increase in number, thus forming a solid wedge-shaped tooth of ice, which constitutes the second stage of development. In the third stage of development the wedge-shaped tooth of ice widens and increases in length as the result of freezing of the water which continues to soak out of the stem. There appears to be no difference between the formation of

these ice fringes and the columnar ice formed on wet soils; other than that, in the latter, a particle of gravel usually forms the nucleus to start the congelation. In both cases the moisture is brought to the surface by capillary action. When the rate of supply to the surface is more rapid than the loss of evaporation, and the air is at a sufficiently low temperature, ice is formed.

JAVA, THE EXPLOITED ISLAND

By Dr. ALFRED GOLDSBOROUGH MAYER

A SURVIVOR from an age of richer color than our own is the templed hill of Borobodoer in the middle of Java.

Here, more than a thousand years ago, the Hindu conquerors wrought honor to their "Mount of Buddha" by surrounding the dome-like reliquary at its summit with ten ornamented terraces of stone, encasing the sides of the hill in an ordered symmetry of angled walls, and portals, and of lattice-covered statues of the Buddha, all wonderful in the vast labor of the sculptured story of their creed.

Then, in after centuries, the sword and the Koran came from beyond the seas and the day of the Hindu passed, to be forgotten as only the East can forget a glory that has gone. Then it was that those who loved the old temple were forced to bury the doomed shrines beneath the kindly sod, and thus in oblivion they survived until the European came to cherish and restore.

Secluded in the deep country far from the haunts of trade, within but apart from the modern world, the temple lies as if dreaming in the spirit of its worshipper's Nirvana; peaceful in the sunset of its days, while green around it lies a valley rich in rice and palms, and, high above, one sees the smoking summits of volcanoes hushed in slumber.

The horde of Mahomet came and the Buddhist died in tragedy, yet after a thousand years the stones of Borobodoer remain as an Alhambra-like reminder of his culture and his pride; but Java with its thirty millions toils on unmoved by any inspiration from its past. Nourished in body, yet starved in spirit, it plods through its thousand rice fields within sight of the temple walls.

The garden *par excellence* of the tropic world is Java, yet intellectually it is but a cemetery of withered hopes and ambitions wrecked in mockery, for over all there broods the dull fatalism of despair—the "sufficient unto the day" of the conquered follower of Mahomet.

Ambition, if it exists in the Java of to-day, seems powerless to raise its people above the condition of the Asiatic peasant. There is no well-to-do class of native artisans, and one may travel throughout the land and find hardly a native shop upon whose wares the European may bestow a glance of admiration, save only for the vanishing art of batick cloth, and the still more moribund manufacture of the Krees.

Ant-like over the whole land, in every view, there swarms the dull-faced, docile coolie of the soil. Measured by standards of morality,

culture and ambition, the Javanese of to-day are negative. Their Mohammedanism is of an insipid type that tolerates the drinking of wine, permits women to go unveiled, is lax respecting the observance of prayer, and sanctions the representation of the human form in art provided the figures conform to the spider-like grotesqueness of the batick decorations. Even a pig fattens comfortably in the back yard, destined, however, to be sold to the "heathen" Chinese. A cloud of abnegation, the despair of a beaten race, broods over the whole land, and bright though the sun may be and green the fertile fields, the spirit of man is colorless and gray, and it is difficult to realize that these crouching, silent forms and averted faces, expressionless as drawn parchment, are those of the descendants of the warriors of Mataram.

How long will the inscrutable face of the East hold back the expression of its hate? One travels from one end of the land to the other and never a hearty laugh is heard, and the air seems heavy with bitter thoughts unmuttered. There are latent things in Java more to be dreaded than the slopes of Krakatoa, where, under a fair covering of flowers, titanic fires lie hidden.

Granted that the only civilization is that which a race achieves for itself, never that which is thrust upon it, yet there is still something wrong here, for the present Javanese outlook upon life is narrower than it was in the past, and a primary cause of the continuance of the evil is not far to seek, for the Dutch, with all their admirable administration of affairs, have, as yet, done little or nothing for the general education of the masses of Java. In the villages, one commonly looks in vain for the temple of any creed, and the school-house, even when present, leaves much to be desired.

A few good schools for the sons of chiefs there are, and upon elementary native education the government spent in 1913 the paltry sum of $1,321,000; and the much larger sum of $3,000,000 upon the improvement and development of agriculture; an investment upon which Java returns a yearly interest, to mention only three commodities, of 3,100,000,000 pounds of sugar, 35,650,000 pounds of coffee, and 92,000,000 pounds of tobacco, the total of her exports amounting to fully $75,000,000 per annum. There are 9,315,000 acres cultivated by the natives and the population of the island is 594 to the square mile; yet of its 30,000,000, the total native population of the five largest cities, Batavia, Samarang, Soerabaya, Djokjakarta, and Solo, is hardly more than 400,000. The vast mass of the people are agriculturalists living in thatched huts in myriads of little villages that cluster among the cocoanut groves of every valley in the land; and practically the only occupations open to natives of Java are those connected with the cultivation of the soil.

This narrowness of industrial outlook has, on several occasions, been

a source of commercial weakness, and Java has not always "paid," despite her conquerors' efforts to secure as much profit from her as their conscience and the public spirit of their times would permit.

The water supply of her countless mountain streams might turn the wheels of many a mill, but Java still sends her products abroad in the form of raw materials, and the cultivation of cotton is not even attempted.

It is a hopeful sign that the natives themselves are beginning to plead for education of a broader sort that will enable the more progressive and intelligent peasants to escape the fate of slaves of the soil, and it is probable that within a few years the Dutch government will respond and the prosperity and happiness of Java will be enhanced, for the Dutch have moved slowly, but surely, in the direction of altruism during their long occupation of the East Indies. They first appeared in 1595 under the lead of Cornelius Houtman who, after adventures and imprisonment, had ferreted out the secret of the route around the Cape of Good Hope to the Indies which the Portuguese had discovered under Vasco da Gama in 1497. Thus it was that the trade which had made the port of Lisbon the richest in Europe, now fell into the grasp of the Dutch East India Company, a corporation which became so powerful that it regarded itself as independent of even Holland's laws, and passed statutes adverse to the interests of its mother country, practically excluding Dutchmen not in the employ of the company from occupying land in the East Indies.

The methods employed in exploiting the natives, while more humane than those of the Portuguese, were still little above those of medieval Venice, and thus it was that, having thoroughly over-reached itself, the company failed in 1796 for $50,000,000.

The natives, goaded to desperation by generations of injustice, broke out into insurrection, which Holland, having been overrun by the French, was powerless to quell.

Then came the picturesque Bonapartist, Marshall Herman Daendels, who governed the island from 1808 to 1811. By force of arms he reduced the power of the native chiefs to a shadow, the substance being maintained in European hands. The great road which he built throughout the entire length of Java from east to west, in the course of two years, is the result of his iron will, the head men of the villages being threatened with death unless they completed their task in time. Moreover, it was Daendels who caused old Batavia, "the white man's graveyard," to be practically abandoned as a residence by Europeans, and moved the capitol farther inland to a healthful site.

Daendels sought, also, to systematize the custom of "forced crops" which had been the rule of the old Dutch Company, at least in places and under various forms. About two fifths of the land suitable for

coffee was set apart and the natives were forced to farm it, the entire crop raised thereon going to the government. On the other three fifths of the coffee area the natives might raise their own crop, but they were forced to sell all to the government at a fixed price much below its actual value.

This autocratic career of Daendels was, however, cut short by the English conquest of Java, which resulted in the able administration of Sir Thomas Stamford Raffles between 1811 and 1815, wherein important and lasting reforms were instituted in the direction of "fair play" for the natives. Suffice it to say that with Raffles a spirit of effective altruism was manifested for the first time during European occupation of Java. In 1816, Java, together with many other East Indian islands she had lost, was returned to Holland; the Dutch profiting greatly by the results of the reforms brought about by the French and English.

Backslidings into old schemes of exploitation there have been, however, as when the government under Van den Bosch, which was in control from 1830 to 1839, took from each native a fifth part of his land upon which he was forced to raise for the government crops of coffee, indigo, sugar, pepper, tea or tobacco. In addition, the natives were forced to pay so heavy a land tax upon their remaining property that many of them defaulted and the government thus acquired the immense tracts which it still holds. In twelve years $830,000,000 in taxes was wrung out of the down-trodden natives who, in order to escape starvation, were forced continually to clear and cultivate virgin soil; despite which the extortionate nature of Van den Bosch's plan was such that famine broke out in 1849 and nearly 500,000 victims perished.

The conscience of Holland was at last aroused, and the system of forced culture has been gradually abandoned, especially since 1870, so that to-day it is no longer a burden upon the natives in so far as their agricultural produce is concerned, although the system still dominates the conduct of the mining industry.

This system, cruelly unjust as it was, had certain good effects. It forced upon the natives habits of industry which they retain to-day, and also by greatly increasing the area of cultivated land it permitted an enormous population to be supported in health and comfort, if not in luxury. In 1816, there were only about 4,500,000 natives, while to-day there are nearly 30,000,000 in Java.

Steady progress in liberal reforms has been manifested by the Dutch since 1870. The island is governed through the direct agency of seventeen native regents who, however, are in each case subject to the "advice" of a Dutch Resident and owe their appointment to Holland. In most respects, however, the natives appear to be self-governing in so far as their immediate affairs are concerned and, indeed, the Regents are permitted considerable "play" if they conform to the spirit of civilization and to the customs of their race.

One thing the Dutch have done which we ourselves might well emulate in our government of the Philippines, and that has been the appointment of commissions composed of the best-trained scholars to study and report upon native languages, folk-lore, customs, arts, religion and history. Many authoritative volumes, unfortunately all in Dutch, have as a result been published upon these subjects and thus the officials sent out from Holland are already prepared to grasp the true inwardness of every native thought and act.

Intending officials in the civil service of the Dutch administration in the East Indies must pass an examination in many subjects relating to the East Indies, and must speak Malay, the official language, and one other native tongue before being permitted to qualify for any position of executive importance. The Dutch, in short, are trying to become the "big brothers" of the natives and a happier and more hopeful relationship is year by year developing in the East Indies between the white master and his brown ward.

This large-minded standpoint has been achieved slowly for, with many setbacks, it is the result of 300 years of association. Yet from this fact alone one may the more safely regard it as a final triumph of the right, and not as a mere transient, semi-sentimental, dip into altruism. It savors of fair play rather than of charity, and of mutual respect based not so much upon fear as upon understanding.

Narrowly self-centered, unaltruistic, and even predatory, the spirit of the Dutch government may have been in the past, but throughout it has been consistent in attempting to develop among the natives the habit of industry.

Under many a kindlier rule native races have lost ambition and have withered to extinction in the vile repose of apathy. Thus in all the world Java is the best example illustrating the fact that given habits of industry, a race can survive the ruin of its independence, its hope, and its pride, and multiply despite a conqueror's exploitation of its resources.

NATIONAL DEFENSE AND DEVELOPMENT[1]

NATIONAL DEFENSE AND EFFICIENCY

By S. STANWOOD MENKEN

NEW YORK CITY

THAT national defense considered merely in terms of men and machinery is directly affected by efficiency is too obvious to require any discussion. When, however, we consider defense of a country in the light of modern developments the extent of the influence of methods of efficiency is readily overlooked.

It is essential in treating the solution of the issue of a nation's defense that the nation should first determine its world position, its relation to other countries, and its attitude toward foreign ambitions; with this knowledge it can then measure its needs. Diplomacy is often referred to as the first line of defense. This is true, and it also must be understood that any defense not measured by the diplomat's recommendations is apt to be unfitted to national needs.

Once the need of national defense is determined, the country must look to the direct application of its assets for its protection; these assets constitute power which is derived from the human, physical and industrial resources of the state. The law of cause and effect determine the extent of the power and bear directly upon the state's influence.

In the past we have found happiness and growth with liberty in strict adherence to democratic principles. We have been greatly aided through our natural riches and the fact that conditions affecting our government were comparatively simple. To-day we have drawn to a large extent on the top soil of our natural resources. We have a more or less concentrated population of a hundred million of people of varied race origin, and find great difficulty in continuing a policy of freedom from entangling alliances. We have wedded ourselves to certain doctrines and thereby assumed certain national obligations without fully providing the means of enforcing them. The transition has decidedly complicated the position of our country and made the working out of its destiny a grave matter, requiring attention and prayerful thought of the best available minds.

When we stop and think of world conditions and measure the re-

[1] A series of papers presented before the Section for Social and Economic Science of the American Association for the Advancement of Science at the meeting in Columbus on December 30, 1915, arranged by the Secretary of the Section, Seymour C. Loomis.

morseless results of cause and effect in the light of knowledge of the economics and efficiency as practised abroad, as compared with our situation here, we can well doubt whether, unless a new spirit grips our land with grim determination, we shall enjoy a continuation of the blessings of the past. To America asleep, to an extent which makes it almost appear that the average man were blind and deaf to occurrences, the efficiency of the German army in the early days of the war was a startling apparition, and yet we know that it was merely one form of expression of the results of a system. The foreign governments that progress have mainly done so in a restricted area under great difficulties, to meet which they use the methods of the laboratory. They apply every human, physical and industrial element to the upbuilding of the state. They know that the success of their system is determined by the individual, personal unit. It is simple, if all cooperate with understanding and with a deep sense of personal obligation, and this sense is the base of natural power.

It is to the philosophy of Kant and the teachings of Fichte that the German spirit of duty to the state finds the impulse which has made German efficiency possible, whether it be evidenced in the army, industry, trade extension or town government. It would be well if America could understand the details of their progress in certain forms of science and of industry, or their success in treating municipal problems, an example of which latter proof of their skill we are able to note that in some cities there are not only no local taxes, but each freeman of certain cities receives a bonus, or dividend, through his citizenship. In one instance this is as much as $100 per annum.

While I believe in individualism, and deny the necessity of the extreme control incident to state socialism, we must fully realize what other nations are doing, and gather what is good and useful in their methods, if we are to have the maximum national growth. If we would proceed with efficiency toward preparedness, we must have the benefit of all possible knowledge of what is being done abroad.

A new era has dawned upon the world. Internationalism, as a practical possibility, is dead for our generation, and our best service to mankind is to insure the maintenance of the growth of this republic. To do so means the preservation of liberty and all that prior generations of thinking Americans have advocated, either in times of war or of peace.

It is because I fear the aggressor, and am too conservative to gamble on the chance that we may not be victims as China and Belgium have been, that I urge with all my power that our country arm to the full extent essential for its defense against attack. America has a great destiny, not alone for service to its own people, but to all mankind, a trust not only for the present, but for future generations, and we can

not stand quiet and assume that chance or national aspirations for peace will furnish immunity; the risk is too grave. We are guarantors of world civilization, which may continue without us, but we must recognize the burden of the hour and meet it, arming and preparing on efficient basis to fulfill the greater purposes of world citizenship.

Preparedness means far more than mere ranks of men, stores of arms, forts and ships. It means the upbuilding of national character, the creation of a mental state of preparedness to do and work for the country on the part of the individual. It means industrial preparedness—it means all these things plus efficiency. In a word, we must, as men and women, give our best thought and apply our strength, character and industry to national upbuilding.

The basic element of any nationality is a people of like origin, speaking a common tongue, having a common understanding and ambitions. Our best defense is a united people. A country divided within itself must fall, and the first duty of our federal and state government is to take steps to unify our citizens of all origins. We must work first through the schools. Next, we should work through the centers of foreign populations. The melting pot has not done its work as yet, and it is possible to accomplish more if the fires of patriotism are heightened and the benefits of good government brought directly to the homes of all classes. This is a matter of serious moment, and it is here I should like to see methods of efficiency first applied.

Next, it is essential that we acquire a spirit of individual preparedness. Because we adhere to high ethical principles in our dealings with our fellow-men, we seem as a general rule to ignore civic duty. Each school should teach American history as it really is, telling the full history of congressional incompetence in regard to legislation, the failure to meet the abolition question for sixty years, the cost of this neglect in men and millions. They should also portray the moral effect of the toleration and continuance of slavery. The historian to serve us with truth should also review the handling of the tariff issue—sixteen bills in a century, with hundreds of disastrous amendments. Let them detail the incompetence of our treatment of trust and finance questions. Let them explain the several causes of the pork barrel legislation and the neglect of conservation of life and of natural resources, criminal beyond expression. I would have them also make clear the methods of the ring politician, the character of the parasites who allow him to be a possibility by lack of public morals and democracy; and, above all, I would like to see this—the history of unpreparedness and the penalty paid by this country in every war it has fought. I should like to see *this* taught with absolute candor, and so brought home to the average youth that he will fully understand the shortcomings of the past; recognize that Americans while personally fair are not super-

men, and feel that if he is to meet the full burdens of his citizenship in future, he has to do his part by personal service toward assuring good government, which will efficiently devote itself, through executive and legislative, to city, state and national affairs. In a word, we must have direct efficiency in government, we must eliminate fraud, penalize those who neglect to serve, and emphasize the fact that each and every citizen has to earn his right to life, liberty and happiness, and that every one is conscripted in that sense for public work.

If we can accomplish a reasonable degree of individual preparedness, all other matters will naturally follow. We shall then have industrial preparedness, which will be so arranged that in the event of our being attacked by any foreign power our manufactures and our commerce will coordinate to serve our army and navy.

To detail the mobilization of industry is not my problem. I wish merely to indicate the necessity therefor as a part of the preparedness which we have neglected. The application of like methods of efficiency to army and navy means the elimination of waste. Useless or improperly located barracks and navy yards are inconceivable in any scheme of national defense that is efficient. In view of our expenditures the conditions, disclosed by Congressman Gardner and accentuated by later developments, constitute a condition of evil for which each preceding national administration is responsible, each in turn. That Mr. Meyer for the navy, Mr. Stimson for the army, pleaded for freedom and funds to do better things does not excuse, but accentuates, the absolute need of new methods of efficiency in the service and strict accountability to the people.

We may advocate national defense and Congress may listen to our plea, but neither laws nor expenditure can give us real protection or preparedness unless we practise efficiency as individuals and as a nation.

THE WISDOM AND ETHICS OF PREPAREDNESS

By HENRY A. WISE WOOD

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AN examination of history, from the middle of the fifteenth century until the present time, discloses the fact that, if the principal European nations be lumped, 52 per cent. of their time has been spent at peace, and 48 per cent. in warfare. England, in 800 years, has spent 419 years at war, or over 52 per cent. of her time, while France, in the same period, has spent 373 years at war. In the twelfth century, England fought over 54 per cent. of her time, while in the nineteenth century she fought $53\frac{1}{2}$ per cent. Not much of a reduction. France, in the twelfth century, fought $36\frac{1}{2}$ per cent. of her time, and in the nine-

teenth century 35 per cent. These figures disprove the erroneous contention that warfare is decreasing.

If we turn to Prussia, the most efficiently warlike of all nations, we discover a very significant fact. Where, in the seventeenth century, Prussia fought 58½ per cent. of her time, by the nineteenth century—during the latter half of which she may be said to have made and absorbed the German Empire—she reduced her years at war to 13 per cent. By the development of military prowess and her thorough preparation she had learned to strike so swiftly and well that her wars were over almost before they were begun. If the war chart of Prussia be compared with those of other nations, all of whom were less well trained and prepared, it will be found that where Prussia quickly finished her fights and got back to work, the wars of the other nations were long drawn out, due as we know to the necessity of their learning and preparing to fight after their wars had begun.

From the foregoing it is clear that the world at large is now, as formerly, fighting about one half of its time, but that the nation which has made a scientific study of warfare, training and equipping its citizens thoroughly therefor, has succeeded during the last century in reducing its periods of warfare to little more than one eighth of its time. That military efficiency and readiness have a humanitarian as well as an industrial value none can longer doubt. That to be prepared to defend ourselves will be as necessary in the future as in the past, the scarcely diminished proportion of its time which the world uses in warfare indicates. But let us be able to defend ourselves so well that our reply to aggression shall be instant success in terminating hostilities.

At the close of the revolution our army was reduced to eighty men, to guard ammunition. By 1812 it had arisen to little more than 6,000, I believe, who were widely scattered along our frontiers. At the beginning of the war of 1812, there were less than 5,000 British troops in Canada, while we, having no army capable of dealing with these, were compelled to raise and train troops before beginning operations. If we could have sent a force of 10,000 regulars promptly into Canada, we should have brought the war of 1812 to an immediate and victorious conclusion, and have added Canada to our territory. Instead, we began to "prepare" after operations had begun, with the result that the war dragged on for two and a half years, during which we were compelled to raise 527,000 troops, and to lose our capital, which, following the Battle of Bladensburg, was taken and burned by the British. In this battle 5,400 American troops fled, with a loss of but 8 killed and 11 wounded, although they were attacked by less than 1,500 British regulars.

The war of 1812 cost, including pensions, $243,000,000. At no time during the war had the British more than 16,500 troops in Amer-

ica during a single year. Had the United States, from the close of the revolution to the beginning of this war, taken the precaution to support say an army of 15,000 men, money would have been saved, there would have been little loss of life, no loss of industry, and Canada would now be part of our territory.

Upton, our great military historian, has shown us that at the beginning of the rebellion had the United States had a trained army of less than 30,000 men the rebellion could have been suppressed at the first Battle of Bull Run. If such a body of men, of even many times this number, had been maintained before the war of secession how little their cost would now seem when set against the five billions of dollars spent by the north and the south on the war, the four billions of dollars since paid out in pensions, the hundreds of thousands of lives lost, the ruin of the south, and the interruption of four years of social progress and constructive industry. In view of these facts can any one question the value of such insurance against war?

The general staff of our army has just shown us that the most warlike nation of Europe, in times of peace, can deliver upon our shores a trained force of 827,000 men in 46 days, and that the most warlike nation of Asia can deliver 238,000 men in 63 days. The general staff thereupon advises that in order to make us secure the regular army be increased at once roughly to 280,000 men, and thereafter be gradually added to until it has reached 500,000. And this, which the general staff considers a minimum, it says, must largely be supplemented by the militia as well as other civilian troops. During Roosevelt's administration we were the world's second naval power; now we are substantially its fourth, while Germany in sea strength is vastly our superior.

If the recommendations of the civilian secretary of war be compared with those of the general staff of the army it will be seen how miserably insufficient is the plan of the secretary to afford us security in the event of attempted invasion. And if the naval increase proposed by the civilian secretary of the navy be compared with the naval list of Germany, it will instantly appear that when the small and slow plan which has been prepared by Mr. Daniels is carried into effect, we shall still be vastly inferior to Germany.

Where the fundamental policies of two nations conflict there is bound to be friction, and where there is friction eventually there may be war. It is a fact that our Monroe doctrine, which has forbidden European nations to colonize in this hemisphere, is in conflict with the colonial policy of the German Empire, as may easily be verified by a perusal of the words of German economists. As neither nation probably will surrender its policy, we find here a point of contact at which danger may arise. Wisdom therefore dictates that, if we intend to enforce the Monroe doctrine, we provide ourselves with a navy sufficient for quick and effective use, if the doctrine be attacked.

Our Asiatic exclusion policy, as practised on the Pacific coast, conflicts with the national policy of Japan, which nation insists that its citizens everywhere shall be received upon a footing of equality with those of the other first powers. Thus, if we intend to maintain our exclusion policy, it will be necessary for us to have a navy sufficiently large to enforce it if challenged. If it so happen that the Monroe doctrine and our exclusion policy be challenged simultaneously by the nations affected, it will be necessary for us to have a navy large enough to defeat the world's second naval power in the Atlantic, and the world's fifth naval power in the Pacific. At the present moment we could defeat neither the two together, nor the first alone, having long since lost to Germany our position of superiority.

Were Germany, with her superior fleet, to make a feint towards South America, and thus draw our fleet in that direction, the remainder of her fleet could safely convoy to our shores the 827,000 troops which our general staff has stated can be landed here in 46 days, when we should suffer the outrage of invasion. If, on the other hand, our fleet were retained in northern waters to protect us, then Germany could easily establish herself in South or Central America, from which it would be next to impossible to drive her. This possibility illustrates the imperative need of our having at all times a fleet large enough to cover the Atlantic, and the Pacific as well, for, if Japan were to cooperate with Germany, we should there have to deal with the fleets of that nation, or suffer invasion of our western coast.

Were Germany to succeed in establishing itself in South or Central America, and there create a standing army and a military base, we should have the military dangers long threatening Europe reproduced within our own hemisphere, and they would soon require us to adopt compulsory military service and maintain an enormous standing army. If, on the other hand, we should shield South or Central America, and permit our own shores to lie open, then, as has been stated, we could easily be seriously hurt, for an army could be landed upon Long Island, sufficiently near to New York to reduce that city with the mortars which have been used with such effect in Belgium. With New York City and its surrounding territory in the hands of the enemy, an enormous indemnity could be levied, in which the whole country would have to participate, while humiliating terms of peace could easily be dictated.

In view of the foregoing, it is obvious that it is necessary for us to equip ourselves at the earliest moment with (*a*) a navy sufficiently strong to defend ourselves both in the Atlantic and the Pacific oceans, and (*b*) to establish upon both coasts a mobile army of sufficient dimensions to repel the expeditions of two nations if made simultaneously.

In view of the mistakes of the past and of the dangers which threaten us, it is plain that it would be arrant folly to refuse to carry out in full the suggestions of the general staff of the army, and the recommendations of the general board of the navy, of which Dewey is the head, which have just been made public. For, however much these will cost, that cost can be but as nothing to the huge price that we shall have to pay in life, devastation and money for our negligence, should our invasion occur.

That preparedness has its ethical side, John Fiske has shown. He has said that the closest approach to a condition of perpetual and universal peace that it is possible to attain among nations can be achieved only when the preponderance of military power has been gathered into the hands of the pacific peoples. It is obvious that our own form of civilization as well as the forms of civilization enjoyed by the other pacific nations are in jeopardy, so long as the machinery of compulsion remains wholly in the hands of those bent upon conquest. So it is apparent that humanity and the preservation of righteousness throughout the world, no less than our own security, require that we shall do our part to redress the balance of power which too long has been permitted to lie with the war-like nations.[1]

THE LOGIC OF PHYSICAL AND MENTAL PREPAREDNESS

By NEWELL B. WOODWORTH, A.M.

PRESIDENT-GENERAL, SONS OF THE AMERICAN REVOLUTION

THE first chapter of American democracy commenced with the Continental Congress and the shots of the "Minute Men" at Lexington and Concord, and ended at Yorktown. Now, after more than a century and a quarter has passed, the deeper meaning of October 19, 1781, can be seen more clearly. Then it was only the eager rejoicing over a great victory that had been achieved after many depressing months, during which the cause of liberty seemed destined to defeat. Now it is seen as a momentous event upon which was to be predicated the Treaty of Paris, which was to give the opportunity for the development of the greatest representative government the world has ever known—a government standing for the highest ideals of individual liberty and equality and of national and international rights of humanity. Thus, through the intervening years since Cornwallis capitulated, a greater responsibility has been developing, as the nation has

[1] Authorities consulted: Researches of Woods and Baltzley; Upton's "Military Policy of the United States"; The German economists, Schmoller, Hotzsch, Vintzer, Unold, etc.; Report, 1915, War College division, General Staff U. S. Army.

extended, upon those intrusted with the trusteeship duties of American citizenship; duties depending primarily upon the maintenance of the entity of this nation and of its principles. Upon this point of maintenance there is no difference of opinion, but as to the method there is a wide divergence. There are those who would have us continue in our present almost physical defenseless condition; there are those who believe in physical preparedness for national self-defense. Thus a present vital issue is clearly joined between these two methods, and the court of arbitrament is the public opinion of our citizenship.

Let us return to the days of Yorktown and ascertain what was believed by our forefathers. The revolution determined the American people could fight. The immediately succeeding years were to determine if what had been created could be maintained. It required six wretched years under the Confederation after Yorktown to bring them to the second crisis. In the adoption of the Constitution of 1789, the American people finally demonstrated their belief in the principles for which they had contested and accepted an instrument of power under which in succeeding years, nationality was to develop. In the preamble of this marvelous document of our forefathers, six reasons for their action are set forth, namely, union, justice, tranquillity, common defense, general welfare and liberty. While five of the six are dependent on force for effectiveness, let us briefly consider only the "common defense."

I believe it is both an opportune time and an advisable time for the subject to be considered in the forum of any assembled body of American citizens, for there are at the present time some sixty "peace-at-any-price," anti-armament and anti-enlistment societies arrayed in an active anti-preparedness campaign against this provision of physical "common defense." This is a subject of patriotism, not partisanship.

Our forefathers engaged in preparing the Constitution were very practical men, nearly all of them having been active participants in the revolution. Their leader was Washington, who, previously to his election as a delegate to the convention, and to his being elected its president, had given expression to a thought that can be considered as reflecting the sentiment of his associates on the subject:

> It is a maxim founded on universal experience of mankind, that no nation is to be trusted further than it is bound by its interests, and no prudent statesman or politician will venture to depart from it.

Later, as president under the Constitution, he again expressed this same thought in the words:

> There is a rank due to the United States among nations which will be withheld, if not hopelessly lost by the reputation of weakness. If we desire to avoid insult, we must be able to repel it. If we desire to secure peace, one of the most powerful instruments of our rising prosperity, it must be known that we are at all times ready for war.

In view of the expressions of so commanding a figure in contemporary thought and from one too who earnestly detested war, it is submitted as a reasonable inference that the makers of the Constitution realized their acts and with due deliberation referred, as one of the reasons for the adoption of the Constitution, to the necessity of a material self-defense for the nation. If this measure of "common defense" resting upon force was deemed necessary in the infancy of this then isolated republic, how much more so is it essential to-day, when modern inventions have eliminated time and distance; when we have as a nation, reached the position of a world power; when our possessions extend into both hemispheres, and when we have publicly announced certain international policies.

Against this assertion of unpreparedness, the radical pacifist, and I am referring alone to the "radical," as all thinking men are at heart pacifists as recognizing the horrors of war and deploring its existence—I repeat these radical pacifists vociferate that no nation is going to impair and disregard our national rights and honor, as this would be illogical; therefore no actual sufficient military or naval force is required for the protection of national entity or obligations, as reasoning is *per se* sufficient for self-defense.

Let us briefly analyze. The weakness of the argument is that the premises upon which it is based are conjectures. Who can assert with finality that no nation will attack us or seek to violate our national obligations? Has any radical pacifist the ability to absolutely ensure or guarantee the nation against such a result, as they venture to so positively assert is impossible? No, it is simply their personal opinion, to which they are entitled, even as those who deduct a different conclusion from events are entitled to their views.

Again, who is to determine whether war in the reasoning capacity of a nation appears as logical or illogical? These logicians of pacifism give us no practical guarantee that will comfortably ensure the acceptance of our reasoning as correct by other nations. Belgium invaded did not consider the action of Germany either reasonable or logical; but Germany did, and Belgium was devastated. Our logic has thus far failed to be unanimously accepted as correct by the warring factions in Mexico. While this theory is quite idealistic and desirable, both from a humanitarian and an economic standpoint, the vital question yet remains a simple one of reasoning, dependent on man as he is mentally and physically constituted in this twentieth century A.D., and not as he perhaps may become later through many centuries of evolution. I place emphasis upon man, as he is yet a creature influenced by self-interests and by human passions. It is man, who yet develops and guides the destinies and policies of nations; the personal equation still controls governments. Selfishness is yet a predominant human characteristic.

To return again to our ancestors, they thought they had reached after the close of the revolution, an idealistic state of man uncontrolled by enforceable law sustained by force, and it required the lawless and turbulent years between 1783 and 1789 to harshly demonstrate to the worthy descendants of Pilgrim, Puritan and Cavalier their error and release them from their thralldom of misery. As General Knox at this time wrote, "Men, actual men, possessing all the turbulent passions belonging to that animal, must have a government proper and adequate for him," and experience then was so fast demonstrating to our forefathers that an "adequate" government was one backed by physical power to enforce its mandates, that they adopted the Constitution of the United States as a "government of laws and not of men." What was then true as regards our domestic government remains true to-day as regards foreign relations, as we have yet no brotherhood of nations to correspond to our brotherhood of states controlled by a strong federal system resting upon a force sufficient to compel observance of its mandates. Our federation ends at our boundaries. Beyond lie different races with different interests and methods of thinking; different customs and forms of government. Each inspired and controlled by its interests, and by the passions of the men who are its active component parts. Who can prophetically foretell or foresee the latent motives that may at any time suddenly bring their principles impelled by so considered self-interests into direct conflict with those of this nation, with only war remaining as the court possessing jurisdiction over the issues raised. Treaties of arbitration are only enforceable like statute and constitutional laws when sustained by an enforcing power, otherwise they become "a scrap of paper."

I do not question the desirability of the pacifist plan; only its present availability. It will doubtlessly develop some time in later centuries. It has required over seven hundred years since Magna Charta for individual liberty and constitutional government in a few of the individual nations of the world to develop to its present imperfect state, for the system is still in a process of realization. Doubtlessly, when this form of government further spreads over the world, as it probably will, as democracy is elementally and historically progressive, the time will be approached when an international constitution of power may be evolved and a permanent union of nations under it rendered as possible and as practicable as is this Union of States under our Constitution. This is, though, of the far future, for despite the assertions of the rationalist philosophers of the pacifist school, men, apparently from recent events, are not yet governed much more by reason and logic and less by human passions than they were in past centuries. These philosophers, who so believe, I fear, are seated upon lofty heights and look over the heads of common human nature below.

We have founded here in this western world a republic, with its doors opened to all races and creeds, rich and poor, literate and illiterate, who have desired to seek personal liberty and opportunities beneath our flag. The duty of those of the present is to preserve these institutions of liberty and to transmit them to their successors in all purity. In so doing we will enlarge our influence in the world and hasten the advance of the ultimate establishment of a permanent international peace. God forbid that we Americans have reached that apathy of mind where it is folly to risk a hair for the mere idea of what some "fanatics" call one's country. Rather, let our youth continue to feel that an adequate defense is a noble duty. If not it is time to return to our Virgil,—"*Arma verumque cano*"— I sing of arms and the man. Rather this than "I didn't raise my boy to be a soldier." No, if war is always wicked and peace beautiful, we must inexorably place George Washington and Abraham Lincoln in a class of murderous leaders and not as the creator and savior of the Union. Is this startling? It should not be. According to the logic of radical pacifism, the men who died on the battlefields of the Revolution and of the Civil War, irrespective of North or South, were not patriots, but rather men who went forth with murderous intent and as the deluded victims of unscrupulous leaders. I, for one, am not ready to accept any premises that lead to such an unholy conclusion. I can not see any valid reasons against an adequate, material self-defensive force for this nation. I can see many forcible reasons drawn from history and life of the imperative need for the security provided by such a proper force. I believe the great majority of American citizens are in favor of "common defense" as inheritors of the principles of the founders of this republic. If they had been "peace-at-any-price" men, they would have, after King George denied their petitions for redress, continued to peacefully lick the British stamps for affixation to their documents. This action would have avoided the revolution of '76 and probably involved our pacifist of the present in the current war as a colonist of Great Britain.

From the record of past events and from the observation of the present character of man, I can only logically deduce from these premises the necessity of physical self-defense. The methods of this preparedness I do not even assume to suggest. This is a question that we should wisely leave with those possessing the highest technical knowledge that the study of a lifetime can alone provide. There is only one question to be deliberately determined, without thought of partnership, only as Americans, by the citizens of this country, and that is physical preparedness, or unpreparedness.

Quite as essential as physical preparedness is the mental preparedness of the nation. This question arises more prominently at the present time because of the heterogeneous mingling of many races in our nation

and of the resulting concentration in recent years in our populous cities of these aliens in racial communities. Hitherto, the great amalgam which has fused into our body politic the many nationalities that have come to share our birthright, has been our common language. In racial districts where the inhabitants are using their native tongue, this language amalgam can not operate, and the alien, continuing to think and speak in native ways, is unassimilated. Obviously, such conditions constitute a menace to that complete unity of our people upon which must ultimately depend a mental preparedness from which must of necessity develop any effective physical preparedness.

Citizenship, whether by oath or by birth, demands loyalty to country. What is required in all is that spirit of loyalty that led Paul of Tarsus to exclaim, as bound and sentenced for scourging and an object of contempt, he brought consternation to the scarlet-clad Roman centurions in his acclamation, *Civis Romanus sum*—I am a Roman citizen—or of Patrick Henry in the halls of the Continental Congress, "I am not a Virginian, but an American." It is a long step, through many centuries filled with the incessant struggles of mankind towards a higher degree of Christianity and civilization, from Paul in the *acra* to Patrick Henry in the Continental Congress, but the words of both, far beyond a mere oratorical expression, represent the very living spirit of political liberty that should thrill with vibrating impulses every citizen of this nation. This active consciousness of loyalty to principle, so essential to the homogeneity of any nation, can only be aroused by teaching our alien citizens through school, precept and example, our language, our methods of thinking and our standards of living; and to all, whether Americans by heritage or by oath, a reverence and love for our flag and a pulsating pride in the protection it affords and in the principles it symbolizes. In seeking this desired result, the thought must be kept distinctly in mind that the essence of a democracy is service to all the people within its precincts, and we must use our influence that such service will be rendered from which impulsively will spring loyalty to country. True patriotism is never an emotional sentiment produced by temporary exhortation; it is the result of a slow growth inspired by the thought that each possesses an interest in a government that serves and protects. It is this deep possessive feeling as to country that leads men to defend their heritage even at a sacrifice of life. It is the depth of this spirit that rallies a nation to unity of action in times of stress, sustained in the hours of adversity and leads it on to victory.

This subtle moral mobilization of the people is quite as essential to the security and permanency of a nation as is the outward physical preparedness of military training and supplies. It was this spirit of disciplined loyalty that gave Rome all its magnificent glory; gave its citizens their pride in the protection of their eagles; gave Paul the poor

tent-maker of Tarsus his exultation of spirit, and, when it failed, the Gothic hordes poured through the Salerian gate and Rome fell. It was this spirit that rallied the "Minute Men" at Lexington, Concord and Bunker Hill, and brought the yeomanry of the colonies forward in every crisis of the revolution. It is a spirit closely akin to the spiritual feeling that distinguishes us from animals. It is the spirit upon which rests all that is worth while in this world of which we are a part in service to our democracy as representing our fellow-men. It is this national spirit that we must teach by word and by example with quickened conscience of the responsibility resting upon us. It presents an opportunity, both collectively and individually, to render national service to our country that we may, through living our own lives, justify our pride in the acts of the founders of this republic, at a time when alone service secured success.

The question we must each ask ourselves is:—Are we giving to our country the actual service for its advancement that we are capable of giving? Citizenship is a trusteeship. The pacifists who proclaim they are quite willing to take a chance on any nation attacking us are placing the future of the republic upon the forbearance of others, not upon the power to assert such a perpetuity. A plan hardly in accord with American traditions or the obligated duties of trusteeship. Again, these chance-taking pacifists overlook the salient fact that they can not separate themselves as individuals from citizens. To them has come, whether by heritage or by oath is immaterial, a life interest only in our government which protects them by its laws and institutions; and, like any life tenant, they have no right to so use this temporary individual interest as to imperil the principal in trust being transmitted intact to their successors. The fallacy of the endeavor to separate individuals and citizen interests is obvious. Rather may we turn to the heroic adherence of the citizens of Belgium to their obligations, even at the cost of war and devastation, as an inspiring example to the people of the United States. Citizenship carries duties of to-day, duties for the to-morrow. God grant that we may realize our opportunities and avail ourselves of the opportunity of service, zealously defending and continuing this republic, not only as a radiant promise, but as a full realization to all races of the world of a government of unity "of the people, by the people and for the people" under the principles represented by our glorious Stars and Stripes. God grant that we may continue to be inspired by the example of our forefathers in placing principle before all things, that we may not be led astray from our present opportunity of practical service to our country. Give us this mental preparedness backed by a proper defensive physical preparedness and this republic, sustained by the integrity, intelligence and conscience of the American people, will lead the way among all nations of the world to an ultimate federation of nations that through

democracy and the wisdom of a Divine Providence, will yet be created to bless all nations with an everlasting peace.

> When the war-drum throbs no longer, and the battle-flags are furl'd
> In the Parliament of man, the Federation of the world.

NATIONAL DEFENSE AND EDUCATION

By HENRY H. WARD

VICE-PRESIDENT OF THE NAVY LEAGUE OF THE UNITED STATES

THE "educators" of our country seem to have been among the last of the more intelligent body of the public to awaken to the necessity—even to the barest idea of the meaning—of national defense. I say "among the last," for among the more intelligent they are far from being alone in their apparent obliviousness to this vital public question.

However, in this attitude, the educator does stand as a most striking figure, in view of the particular relation which he holds to the public, as one whose profession is to impart pure knowledge on whatever subject. Apparently he has been little, if any, better informed than the average intelligent man of other professions. In fact, outside of the naval and military professions themselves, including, of course, the National Guard and Naval Militia, and outside of one or two heretofore struggling patriotic organizations, there is practically no scientific or consistent interest shown in this subject. Even our best informed men in civilian life, unless they have been brought into actual contact with naval and military administration, fail to recognize that here are two actual professions. Many of us so often pass them by with the idea that the army begins and ends in the few thousand men wearing uniforms and trained to a certain disregard of life, be it their own or that of others; the navy we look upon as little different from the army, except as it may be thought to differ in the matter of romance, or in the supposedly free and easy life of the sea and careless travel.

Now that the educator, along with other intelligent men, is awaking to the meaning of national defense, and to our country's need for it, his interest is becoming vivid and his activity dynamic. He stands forth potential for great national service, but not without some possibility for harm. There is, then, the greater need that he intelligently direct his efforts. The proselyte to the cause, be he educator or whoever he may be, starts out relatively ignorant of a vast subject. He learns a little, fails to realize the nature or extent of the subject before him, and, enthusiastic for this or that method or measure, not infrequently gives his energies along some misdirected line, or fails to realize full value from the energy that he expends.

There seems, too, to be a certain confusion, or lack of understanding, as to the alignment of public opinion, intelligent or otherwise, on the

matter of national defense and preparedness. It is too often assumed that the work of the so-called defense societies, and of the peace organizations, are necessarily entirely antagonistic. That such is not the case, provided we exclude the possibly mythical "Peace at any price" section, a moment's reflection should convince you.

What, then, is the function of the educator in respect to these questions, and where lies the relation between education and national defense?

For years back, various organizations have been endeavoring to conduct a work of public education as to the proper means of national defense. Conspicuous among these bodies, and oldest of those now active before the public, is the Navy League of the United States, which, since its organization in 1903, has been single in its purpose to inform the people of the country as to the needs of the navy and the country's need for a navy. Officers and workers of the league know only too well the country's past apathy toward this subject. Where there is apathy there can be nothing but ignorance; and upon this subject the country has been and is to-day woefully ignorant. We have been awakened by the European war. It is true that our interest is aroused, we are more willing to believe what has been told to us, but, so far, it is largely a matter of faith, and if we are to give wisely of ourselves, we must be taught.

Two years ago there were few who would have known whether our battleships were faster than those of England, of Germany, and of Japan; and, except for the boyishness of the American heart, few perhaps would have cared. Our dailies, and our periodical press, gave us recurring accounts of the launching of this vessel or of that. And were we not always told that each was the best in the world? To-day we have a little education on the subject. We know that those same ships, powerful though they are in many respects, are relatively slow; and, the while we are ceasing to be boys, we are beginning to care a great deal. We are no longer satisfied with the easy and boastful assurance of a few months ago. We want to *know*. And we want to know that we *have* the best in the world, or, if we haven't, how we can get it. We want to know this, not only in regard to battleships and battle cruisers, scouts, destroyers, submarines, fuel ships, hospital ships, supply ships, repair ships, air craft, mines, mine layers, mine sweepers, guns and armor, torpedoes, dry docks, navy yards, and shops and shipbuilding slips, and in regard to naval organization and administration, but we want to know how we can get that best in whatever else is needed in that other great branch of our defensive service—the army. Shall we know if we listen to the ignorant? Have we learned enough to form any adequate conception of these two complex establishments that must be welded into a harmonious whole for national defense, each one presenting in its manifold ramifications two great sides—each based upon and guided by a profession rivaling in complexity, specialization, and variety any in the

world, and yet each in its physical embodiment challenging our great industrial establishments, and together destined, should the hour come, to mean for us life, and perhaps honor, for self and family, and for the nation? If we have learned so much, we shall not be satisfied to take our further lesson from any tyro. The "two-man submarine," that patent David, child of an ignorant brain, will fail to charm us. "What do the doctors of the profession say?" we shall ask. We shall require to have their answer given freely, and without tincture of politics or of politicians, and without thought of money cost. And when we have heard that answer, we shall say if we can pay the price. But, as responsible beings, we shall have informed ourselves of the dangers of unpreparedness and as to our ability to pay. With the catastrophes of Europe and of the Near East before us, with history with equal lessons of horror, and with its other lessons to guide us, can we doubt what our decision must be, even if the chance of attack be slight, and the cost of safety great?

Even to-day we are walking in the dark. We have been cheered by the announcement that the Secretary of the Navy has approved a five-hundred-million-dollar construction program. It is true that it is to extend over a period of five years, but that is the rate of one hundred million a year for new construction, and heretofore we have spent a bare one hundred and forty millions or so annually on the building and maintenance of the whole navy. We picture to ourselves this money already buying us the protection that we are beginning to think we need, but how few of us know, or have ever informed ourselves, of the laborious, halting course of routine appropriation and expenditure of government funds for construction. Five hundred millions of dollars—the words ring big. The truth of the matter is, as shown by the Secretary in his own report, that not over fifty-seven millions of this is required for work to be done before July 1, 1917—one year and a half from now. Added truths are that probably not one dollar of this whole sum will be spent on new construction for another nine months unless extraordinary measures are brought into Congress to accomplish it. For years past, it has been the rule that from eleven to twelve months have elapsed after the secretary's report has been issued before the first dollar actually goes into a battleship, and it is only when it gets into the battleship that the dollar does any good; or, I might better say, that it is even then two years to the time before a ship is finished, and the dollar will really pay us back in the shape of tangible protection.

The events of the past year show an even more discouraging state of affairs. It was considered, for reasons that can not fully appeal to the mind sincerely believing in the necessity for national defense, that we should not accept the bids of private shipbuilders for the construction of certain recently authorized battleships. Instead, their building has

been entrusted to navy yards, and pending the fitting out of the yard with the proper facilities, and the getting of the necessary appropriations from Congress for that purpose, nothing will be done, and ships authorized nearly a year ago will not be laid down for months yet. I do not intend to suggest that there is inherent objection to the building of ships in navy yards, but only that they should be built where they can be most quickly built. A similar mental attitude has resulted in a failure to recognize that the only dry dock that is worth anything for national defense is a dry dock built and completed, and not merely a dry dock authorized, or half erected. This attitude has delayed for one year authorization to resume work on the dock at that important naval outpost—Pearl Harbor—in the Hawaiian Islands. A state of mind, similar to the one just mentioned but similar in only one respect, that of its blindness to public interest, has left the naval station at Guantanamo uncompleted, because it was so much easier to get appropriations for Boston, or Charleston, or Portsmouth, New Hampshire, or New Orleans, or Brooklyn, or Pensacola, than for Guantanamo, where there is nothing else but the country's ends to be served. The fault does not lie with any one party, or with any one group. It lies with us who have failed to inform ourselves, and with those of us who, being informed, have not had the strength or public spirit to inform others.

Let us not be turned from the truth by the ignorant, the weak, or the insincere. Let us not believe when we are told that "Protection does not protect," or that we can not "afford" the cost, or, more specifically, that we have not the shops or building slips to build what the experts say we need. Protection has protected England for centuries, is protecting English homes and honor to-day, and, though at the further cost of tens of thousands of gallant lives, is giving new life to hundreds of thousands equally gallant, who have been willing to risk their all for honor and their country. The cost? A paltry billion or so spent as soon and as wisely as we can spend it, not spread out over years to come, spent while England and France and Germany are each spending their billion in every three months, will more than do it all. The shops and shipbuilding slips? The General Board of the Navy—our doctors—have said that we can have for the first year a program double that put forward by the secretary of the navy. And if our doctors are wrong, get from the broad profession of the navy better and more competent advisers for the future, and in the meantime, to correct our mistakes, put our hands in our pockets, spend the money, and build the slips and shops, and do it right away, not a year from now.

Now, the way to decision free from doubt, and the way to action in this matter, lies in knowledge and understanding, and, as always, the way to knowledge and understanding lies in study—in education. We must study; we must educate ourselves, and then take our part in edu-

cating others. When we have learned what our condition is, when we have learned, for instance, that the ocean is the surest, quickest, and safest highway for a foe, unless we can outmatch him upon that ocean, when we have learned the truth of our past military history, its failures and extravagance, we shall see clearly where lies our only hope for the future, and doubt will leave us. Here is legitimate work for the universities, the colleges, the schools, and the teachers and students of this country. It is not their part, commendable as is the spirit, to put forward schemes for military instruction and training within academic walls. If this be part of the military scheme recommended to them, let them take it up; but for their own initial work, let them rather teach the broad unbiased truths of military and naval history, let them create an understanding of the national and international problems of the day, let them face the issue squarely, so that an educated public, educated to the truths that bear upon national life and honor, shall intelligently and bravely, without complaint or fear, knowing full well what it does, but forgetting self, offer sacrifice, if need be, for what in truth for us is and shall ever be the greatest country in the world.

THE ECONOMIC AND STRATEGIC VALUE OF THE LINCOLN HIGHWAY AS CONSIDERED FROM THE STANDPOINT OF NATIONAL DEFENSE

By AUSTIN F. BEMENT

SECRETARY OF THE LINCOLN HIGHWAY ASSOCIATION

NATIONAL preparedness for defense is the question of the hour. Public attention has been diverted to this topic by the press and every other agency for the securing of the nation's attention for many months. Undoubtedly it will be the greatest point at issue in the national presidential campaign of 1916. Yet it is not essentially a question of politics, and for this reason has secured the greater interest which is being given it. We are hearing more to-day about the condition of our national defense or lack of defense, and about our army, our navy, and their needs, than at any time since the Spanish-American war. Every point at issue has been argued and re-argued from every standpoint, with the result that the average man's interest in and knowledge of the subject is perhaps greater at this time than at any other time in the history of the country.

Certainly national defense has never secured so thorough and wide an attention as since the outbreak of the European war, and yet in all the discussion of the matter, and it is almost impossible to pick up a daily paper or magazine without finding one or more articles on the

subject, the question of roads from the standpoint of national defense is conspicuous by its absence. Yet the good road has played a most important part in the present European conflict, and its necessity in any plan of national defense is apparent to any student of the conditions which underlie modern mobilization, concentration and military strategy in general.

Brought face to face with the question of national preparedness, we have no more important factor to consider from an economic and strategic standpoint than the development of our road system. In the abstract, this subject is too broad for brief consideration, but no better concrete example can be considered than that of the Lincoln Highway extending from New York to San Francisco, and in considering this road from the standpoint of national defense, it may be considered that we are presenting facts and figures which may be applied to any through, connecting road in this country, or to the country's system of roads as a whole, if we assume that such a thing exists.

The attention of the nation is being called to our facilities and lack of facilities for defense by some of the most learned students of the question in the country, both civilian and military. It is only natural that public interest in this vital question has grown daily as events in Europe have forced upon our attention the costly lessons of modern warfare and the penalty a modern nation pays for unpreparedness. Not the least forceful of these lessons is the necessity for proper means of transportation of men, supplies and artillery by other and more flexible means than by rail.

The rapidity of events which has characterized the present European conflict has been bewildering, due to the extensive use which has been made of the motor-propelled vehicle. So extensive, in fact, has been this use that the present war has been called the motor war, and will doubtless go down in history as such. The cinematographic rapidity of mobilization and concentration by the belligerent powers, reveals the years of scientific preparation which made it possible—preparation of means as well as men.

The rapid movement of troops from frontier to frontier, the swift concentration of forces at needed points, the speed with which maneuvers have been executed, have forced a new system of military tactics, and bring out in a way which has impressed the most thoughtful of our economic students this lesson which we in America need above all others—the importance of roads, good, through, connecting highways, in any plan of national preparedness for defense. They are a necessity at any time, and for a hundred reasons, but we will consider them from the phase to which we have limited ourselves—that of preparedness—and we will consider them in a comparative way with those of the belligerent nations across the sea.

It is certain that England could never have mobilized nearly 100,000 men in 24 hours, as she did in the fall of 1914, over the roads we call "good." To do it she had at her command 150,908 miles of improved public thoroughfares upon which she spends the sum of $40,000,000 each year in upkeep. And these are roads in a country the area of which is less than the state of Florida. Germany could never have massed and hurled her troops at the Belgian frontier over the highways to which we are accustomed. But Germany has 36,000 miles of state road in the best of condition, and in Prussia alone, it may be noted, $36,000,000 a year is spent in keeping these highways in the best of condition.

In Europe the strategic value of the good road has been too often impressed upon the people by the terrors and bloodshed of actual warfare. If for no other reason than their necessity in the movement of troops, the roads of France, England and Germany would be kept up to the high standard which has characterized them for half a century. It is unfortunately true that their peaceful uses seem to be considered incidental.

The development of events in Europe, however, has given us cause to stop and consider our own facilities for transportation. It is to our interest and profit in this connection to compare our possibilities of rapid concentration and movement with the records for efficiency and speed which the past eighteen months have established. The precedents for comparison at our command are relatively few. The entire range of the activities of the Revolutionary war covered a territory less in area than that of the state of Pennsylvania. Yet we know of the hardships suffered by the colonial troops. As we turn the pages of any authentic history of those stirring times, we read again and again of the exhaustive struggles of the men on the long marches. It is difficult for us to conceive at this day the extent of their struggles, but it is a certain fact that these troops suffered untold tortures and endured the greatest of hardships in merely crossing New Jersey, or in marching a few hundred miles in Pennsylvania—a trip which we can make today in a few hours' riding. We can drive by motor to the beautiful chapel which marks the spot where Washington and his men endured the hardships of the winter of 1778, and in so doing, it is doubly hard to believe that we cover in a few moments of comfortable riding the very stretches which meant hours of painful marching to the exhausted continental army. Wherein lies the difference? Not in the motor which would have been useless on the highways of Washington's time. The difference lies entirely in the roads. Had Washington had our present eastern roads over which to maneuver his men, the historic result might have been even more quickly accomplished.

A more modern instance is brought to our consideration by the

events of the civil war. The great rebellion in actual scope covered less territory than is comprised within the boundaries of the state of Nebraska, and yet the terrors of its marches, with men dropping by the roadside with exhaustion or struggling ankle deep in mud with their shoulders to the wheels of heavy artillery which the spent horses could no longer move, are still vividly remembered by the men who survive. There is, indeed, room for comparison here in the ways and means of economic preparedness, but they are insignificant when held up to view beside the events and possibilities of to-day.

The Spanish war furnished an example of confusion in the lack of preparedness and proper facilities, for the movement of our men and supplies with which it is certain our country would be confronted even yet in time of need. This conflict is our only real basis for comparison with conditions such as those with which Germany and the Allies have been confronted, and it pales to insignificance in comparison with the greater conflict now in progress. Much as we regret to acknowledge it, it must be admitted as a fact that our transportation facilities were so inadequate that thousands of freight cars filled with drugs, food, clothing and supplies laid in the railroad yards for weeks and months in such confusion and congestion that the only way of determining the contents of a car was to break it open, and, at that time, the movement of American forces was for the purposes of invasion; there was no menace to our shores, no men were required along our borders, speed of movement was not so essential. Despite the fact that our coast lines were unprotected, they were in small danger.

The latest instance afforded us for the purpose of comparison was the mobilization of regular troops on the Mexican frontier during the administration of President Taft. This was done in an orderly way, but it was a leisurely movement of a comparatively small body of men. The railroads were sufficient.

A misdirected patriotic conception is responsible for the generally accepted thought that millions of men would respond to the call to arms in case of necessity. Accept this as a fact, and we have yet to consider the most serious phase of national defense. Ours is a country of vast area. Its seaboard coasts are thousands of miles apart. It takes no stretch of the imagination to picture the confusion of traffic of any great number of men, whether in Chicago, Detroit, New York, Buffalo, Philadelphia or other central points, in their endeavor to get to the point where they were needed. No authority of statement has ever been voiced that our railroads would be sufficient. It would be a physical impossibility to put even 100,000 men on our western coast inside of a month even without considering the supplies necessary for such a large body. Six railroad lines that can really be called transcontinental, none of them doubletracked through to the coast, would

constitute our only connection with the Pacific coast, should foreign attack be concentrated there. It would take a month to take even a relatively small number there by way of the Panama Canal, and we have none of the marine facilities to be used in such an emergency in transporting men by sea.

The next thought is roads. A system of good roads, even one good road between New York and San Francisco—the strategic value of a completed hard-surfaced, broad, smooth and straight Lincoln Highway from coast to coast—can not be overestimated. Over it without delay we should be able to transport by motor all the men with their accoutrements necessary for the defense of either coast against the inroads of an invading army. There are two million automobiles in the United States to-day, an ample number of which could be placed at the instant disposal of the government at such a time. In one city of the United States last week there were manufactured over 10,000 automobiles. In one month the number manufactured in that city would provide sufficient cars to place an army of 100,000 men on our Pacific coast in from 12 to 15 days. One hundred thousand men, with all their equipment, crossing 3,400 miles in less than three weeks to the defense of their country—it would be the greatest military exploit in the history of the world. It could be done. The United States produces every day more automobiles than the combined factories of all of Europe and the rest of the world can turn out in a month. Given two weeks notice, and more than 50,000 motor cars could be placed at the disposal of the United States War Department. Put only two men to the car, fill the tonneau with food and ammunition, and with 75 feet between the headlights of one car and the tail light of the next, the first would be pulling into Chicago when the last was leaving New York City.

Such a plan is not the mere impractical visioning of theoretical dreamers. It is the result of technical knowledge and far-sighted ability of some of the best military and civilian authorities of the nation, who can not and have not disregarded the lesson which the events of the past eighteen months in Europe have impressed upon the world.

World conditions and war conditions have changed mightily. In no previous conflict of the world's history have we read of a battle line 500 miles in length, or of armies of millions. The facilities for rapid movement and flexible maneuvering of large bodies of men have made wonderful progress in the last few years. We gasp at the rapidity and precision with which great armies of from one to four million men have been mobilized and moved—at the ease with which heavy artillery, guns of a caliber never before movable have been rushed from one battle front to another—but we can not disregard the fact that at the bottom of all this efficiency, of this rapidity and precision of movement, lie the hundreds of miles of good roads which cover Europe like a network.

It is hard to secure for publication or public quotation the real opinions of any of the officers of the United States army on a question of this kind, for obvious reasons. The officers of our national guard are not so hampered or restricted, and the following excerpt from a letter I recently received from Major John F. O'Ryan, division commander of the New York National Guard, will express, I believe, the opinions of the majority of the military officers of the United States forces:

> The value of a coast-to-coast highway, such as the Lincoln Highway, is self-evident from the military point of view. Motor transportation has been developed so rapidly during the past few years and there are now in use in all the states in the union so large a number of commercial trucks, that they constitute an important factor in any problem involving the transportation of men and supplies within the continental limits of the United States in time of war. It may be safely assumed that this wonderful development in mechanical transport of motor transportation will each year have an increased value.
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> The efficiency, however, of motor transportation is largely dependent upon the character of the route over which the vehicles operate. It is the experience of every motorist touring in this country that the good roads over which rapid progress may be made with safety are unfortunately separated from other roads of like character by miles of wretched country road, and that the good time made in traveling on the former is frequently neutralized by accident and delay superinduced by the latter. It is this "crazy-quilt" pattern of road-making which lessens the value of good road work in the United States so far as military uses are concerned.
>
> The Lincoln Highway project, when completed, will avoid this objection throughout the entire length of the immense travel zone which it will traverse. Few civilians realize how inadequate the great railroad systems of this country would prove for immediate concentration of large military forces with all their horses, mules, wagons, camp equipages, impedimenta and supplies.
>
> The availability of a highway such as The Lincoln Highway would permit its use by fleets of motor trucks carrying supplies, the effect of which would be to relieve to that material extent the pressure on the railroads, and permit the transportation of a greater number of troops in a given time.
>
> Certainly the project would appeal to military officers whose studies force upon their attention the value of time in a defensive operation.

The European war should teach this country more lessons than one. It has brought home emphatically our need for a more adequate national defense. This is a federal consideration. It *should* bring home one of the most obvious and one of the most needed of the lessons—that of good roads—which at present is in this country a state question, a county question and a local question, and one in which every voter should take the most intense and personal interest. We do not have to wait for Congress to provide us with this great aid in an adequate scheme of national defense. We know that roads are an investment and pleasure in time of peace, and a tremendous aid in the transportation of manufactured products and farm produce. We know that they lower the cost of transportation, and thereby lower the cost of living,

and we have had proved to us that they are a necessity and a wonderful aid and defense in time of war.

Let the nation concentrate upon the rapid movement and completion of our main, through, connecting thoroughfares. The Lincoln Highway is the backbone of any national road system in this country. The efforts of the people as a whole should be concentrated upon its permanent completion in hard-surfaced material. The people immediately along the route of the Lincoln Highway realize the tremendous advantages of this road, and their appreciation of these advantages has been shown by the expenditure of over three million dollars in road construction and improvement on that route since its announcement and dedication in 1913.

But the meaning of this road as a connecting link between our two coasts, as a national defense, as a first great object lesson to the people of the country as a whole, should be realized in Maine and Florida, Texas and Oregon, as well as in the states through which the route actually passes. The Lincoln Highway is a *national* road. It should secure national support. Already the force of its example has resulted in hundreds of paralleling and bisecting routes of through travel which, with their branches and countless sub-branches, will eventually cover this country with such a system of roads as has enabled Germany, France, England and the other European belligerents not only to rapidly mobilize their troops for defense or effective offense, but to transport in times of peace the food produce of their farms, and the manufactured products of their countless industries at a cost per ton from one fifth to one twenty-fifth of the American cost. The gigantic sums wasted every year in transportation in this country alone would provide us with a dozen transcontinental, hard-surfaced highways as the foundation for national defense, and a national prosperity hitherto unequalled.

We have no immense standing army, and many question the advisability of one. We have few forts. Our coast defenses are limited, and would be practically impotent against a general and concerted attack. This is admitted by no less an authority than the secretary of war, and has been brought to the attention of the nation by the reports of the general staff. Our navy can be at but one place at a time, and we have the longest coast line of any nation in the world. But give us the means of putting men in great numbers upon either coast with facility and dispatch, give us the means of organizing, mobilizing and transporting our vast citizen soldiery, give us the Lincoln Highway completed, hard-surfaced, connecting the metropolis of our east coast with that of our western shores, give us a system of roads in the United States such as Europe can boast, and our boundaries are as safe as though they were bristling with forts and 18-inch guns.

Abraham Lincoln has said:

> With malice toward none, with charity for all, with firmness in the right as God gives us to see the right, let us strive . . . to do all which may achieve and cherish a just and lasting peace among ourselves and with all nations.

The great war president longed for peace, and it is appropriate that the greatest peaceful work of our people as a whole—a tremendous highway uniting a nation in the bond of brotherhood—should also be a great national defense against war, giving us the means of preserving the peace of our people and the tranquility of our homes against all nations, as well as being a most stupendous memorial conception to the honor of Lincoln.

It has remained for the European war and its bloody lesson of unpreparedness to bring out in an emphatic way another and hitherto disregarded reason why we should unite as a nation in pushing through to completion the Lincoln Highway and its connecting roads.

AGRICULTURAL EFFICIENCY A FOUNDATION FOR NATIONAL DEFENSE

By HOWARD H. GROSS

PRESIDENT OF THE TARIFF COMMISSION LEAGUE, CHICAGO

AGRICULTURE was not only the first, but it is the greatest of the world's industries. One of the sons of our first parents tended the flocks, while the other one tilled the soil. From that day to this, agriculture has led in the advance of civilization, and its status is practically an index of it. The principal needs of mankind and most of the wealth of the world come from the upper two feet of ground. No nation of large area ever became great and remained so that did not feed its people from its own soil. It is a matter of history that the neglect of agriculture marked the beginning of the end of the Roman Empire. One of the highest duties and principal safeguards of any country is a provision for a sure and inexhaustible food supply, and this, if possible, should be produced within its own borders. In our opportunity to do this, we are fortunately situated. God's best physical gift to man is a fertile land that is spread unevenly over a portion of the earth's surface, and of which we have a generous allotment. It is our duty to use and not abuse this great heritage.

In the early days of the republic, when there seemed almost as much fertile land as sky, we were prodigal in the use of the soil, we abused our birthright, and for a hundred years, spreading from a fringe on the Atlantic coat to the golden sands of the Pacific, we have been depleting our soil by one of the most prodigal, wasteful methods of agri-

culture ever known. Fortunately, our people awakened to the danger, and they did it none too soon. Far-seeing men, more than a generation ago, became alarmed at the trend of agriculture. It became apparent that something must be done. Growing out of this, the first notable step was taken in the passage of the Morrill Act in 1861, establishing agricultural colleges by land grant. This was succeeded by other acts of Congress, such as the Hatch act, the Adams act and the Nelson amendment, which have amplified and strengthened the colleges, created experiment stations, and, through these, a vast body of knowledge has been created relating to the subject of agriculture, the intelligent application of which makes it literally possible to make two blades of grass grow where one had grown before, and to make grass grow in localities where it never had grown before; and at the same time to build up the soil to even greater fertility. No greater work for our country could possibly be done.

The latest and probably the most notable enactment ever made by any government for the advance of agriculture and civilization was the late Smith-Lever agricultural extension act that came into operation July 1, 1914. In referring to this act, the distinguished Secretary of Agriculture, in his report for 1914, says:

> This measure is of vast significance. It is one of the most striking educational measures ever adopted by any government. It recognizes a new class of students, a class composed of men and women working at their daily tasks on the farm. The federal and the state governments take the adult farmer and the farm woman, as well as the farm boy and the farm girl, as their pupils. The measure provides for cooperation between states and the federal government, it guarantees a coordination of the forces of the two jurisdictions, it places the plans of the two great agencies in conjunction, eliminates waste and friction and insures efficiency.

Good judges are in agreement that the logical sequence of this great enactment, supplemental to those going before it, is that the great industry of agriculture will become more profitable to the man upon the soil and more interesting to his children. It means a redirection of agriculture upon scientific lines. It means efficiency, it means a higher and a better civilization. It will help build up our rural communities and, without doubt, will serve to check the enormous drift from the country to the city. This was the result of the application of a plan less perfect in Western Europe. It will do much to stabilize our industries and enable us to weave a strong industrial fabric without which we could not hope to reach a high degree of national efficiency.

Should we ever be called upon to defend our national honor or existence by force of arms, our strength and our ability to do so successfully must rest upon our ability to respond to the nation's need in food and wealth as truly as with cannon and battleships. Even with a low average acre yield, the total value of the output of our soil from all

sources is approximately ten billion dollars per year, a sum so vast that the mind can not grasp it. The Dutch Commissioner of Agriculture told me, while driving over Holland and discussing the progress that had been made in his interesting country, that, in his opinion, the Smith-Lever enactment was the greatest piece of constructive legislation in all history. He remarked: "You have now approximately one hundred millions of people and in fifty years, if you go on with your wonderful progress, you will have two hundred millions." Our yield of cereals per acre is less than that of Western Europe, so we have a wonderful opportunity to increase our production, and those in a position to judge best agree that it is conservative to assume that within ten or fifteen years at most the value of our soil output will have increased at least fifty per cent., or an annual increase of wealth of five billions of dollars. This colossal sum is five times greater than the combined capital-stock of all the national banks in the United States, and is twice as great as the combined earnings of all the railroads in the land. Thus we see that the future holds for us a great opportunity. Shall we measure up to it?

The destruction of life and property in modern warfare is appalling. It is no longer a battle of men, but a conflict of machines and chemicals. God grant that we soon reach a point in the world's civilization where differences between nations will be adjudicated on the basis of moral right instead of physical might. But until that time shall come, it is essential that every nation should be prepared to defend itself against any aggressor. While we are comparatively isolated from the world's troubled centers, I believe we are facing a situation of grave peril. This awful conflict in Europe in eighteen months has caused a money waste, aside from the destruction of public and private property, that approximates the startling sum of forty billions of dollars. This colossal figure represents an amount practically equal to the cash value of all farm property in the United States.

This conflict must end when human endurance has reached its limit or cash and credit have been exhausted. In the aftermath, democracy will be put to the supreme test. Our own country will remain as the world's money center and will be the chief creditor nation of the world. Our wealth will excite the envy of all the nations, and with a storehouse so overloaded with the good things of life, it may be a temptation to those nations that have suffered so severely, but that are yet strong in army and navy, to insist upon some readjustment of the world's wealth. Are they not in a position to enforce such a demand upon us as matters now stand? I am not an alarmist, but our situation is such that it demands immediate and patriotic consideration by every thoughtful citizen.

The world is amazed at the wonderful resourcefulness, strength and

efficiency Germany has shown in the last eighteen months. For the solution we have not far to go. It lies in the fact that thirty years ago the Empire began a systematic and scientific development of all its industries, including agriculture. The government assumed as its duty the correlation and direction of the industries and the development of its resources, and it has done so until they have reached the highest standard of efficiency that has so far been attained. Their handling of the tariff is a lesson to the world. In dealing with this subject, the purpose from the first was not to build up individual and favored industries, but to strengthen the Fatherland. The tariff was handled along scientific lines and every industry was given due consideration. On the other hand, this subject with us has been a question of pull, politics and favoritism. If the unnecessary economic waste that our method of dealing with the tariff has brought upon us for the last thirty years could be totaled, the amount would be appalling. Germany's science, Germany's forethought and industry has enabled her to weave the most wonderful industrial fabric the world has so far known; and this is the foundation that is now supporting the mighty military burden she has been and is now subjected to. One of the notable phases of preparedness of Germany was the success in handling her agricultural resources, providing food and supplies within her own borders.

Covering the general question of efficiency and preparedness, there are two phases of the subject—the preparedness for war and the preparedness for peace. In the one, we make provision to defend our land from physical invasion by enemies, while in the other, the necessity is the protection of our industries and our commerce. Thus preparedness for us has a double meaning, but in both of these agriculture plays a leading part. If I were asked to state in a word a summary of the whole situation, it would be that scientific accuracy must displace guess-work; that the administration of the government must be for all the people and that the common good must be the paramount consideration; that the politician must go and the statesman must appear.

The bane of democracy and its greatest menace is subverting every issue to consideration from the angle of party politics instead of that of statesmanship and general welfare. The concept is that, like love and war, all is fair in politics, and that politics must dominate public business. It is not an exaggeration to say that at least one half of every dollar raised by taxation is wasted by the grossly inefficient way in which public business is done. Many well-informed persons know, and I think most of us believe, that if the hundreds of millions of money appropriated for defense could have been wisely expended under the direction of expert advice that we have had from our army and

navy boards, we should at this time have been in a position where a strong defense could be made against any attack upon our coast line and give us a sense of security that in these troubled times we can not now feel. We are approaching a world's crisis, which will come as an aftermath of the awful war. It is exceedingly important that no time be lost in preparing to meet it, both from the angle of a possible war and (no less) from the angle of a certain peace and the readjustment that must follow it.

In view of the seriousness of the future that confronts us, it is nothing less than a crime to permit pull and politics to have any influence whatever in bringing our country to the best possible position to meet any crisis that awaits us; and any man who insists upon continuing to play politics should be denounced as a public enemy. There is no subject that it is more important to take completely out of the domain of politics than the adjustment of our tariff. It is the one effective means of raising revenues and protecting our market from becoming a dumping-ground for the rest of the world. As matters stand to-day, the United States is the one great cash market. It is the world's largest consumer and its means are ample. A suggestion has been made that the government should, through the Department of State, have the consuls deal with the matter of importations and if they found that the goods offered would demoralize our markets, they might withhold their consent and prevent shipments. This would be an unusual and extraordinary measure. Would these government agents be in a position to accurately determine the issues? Would not foreign countries resent such drastic action? Would it not be regarded as gratuitous and unwarranted? It would create no end of friction and would probably result in long and vexatious delay and, possibly, international complications. We have reached the time when we should endeavor to make friends abroad, instead of enemies. The best plan is to follow the custom and deal with these questions through the usual channels of tariff legislation. Before we go far, we shall undoubtedly find it expedient for Congress to fix maximum and minimum rates, with a wide margin between them, and authorize the president, on the recommendation of a real, bona fide, non-partisan tariff commission, to put such rates of duty in force as the exigencies of the case may demand from time to time, subject, of course, to review by Congress. To any thoughtful man it must be apparent that membership upon such a commission is a man's job, and the body charged with this duty should have nothing else before it. Dealing with the tariff in this manner will ultimately remove it from political controversy, will stabilize business and give us tranquility where now we have turmoil.

PEACE THROUGH NATIONAL DEFENSE

By ANNE ROGERS MINOR

WATERFORD, CONN.

THE war in Europe, terrible and hateful as it all is, is awakening a new patriotism in the United States. We see clearly the weakness of our position when forced to make demands of other nations. We see our almost defenseless coasts, our slow-growing navy and our very inadequate army. The grim realization of these facts is forced upon us, and we now know it would be criminal for us to persist longer in our traditional policy of unpreparedness and ignorance—a policy which has continued from the beginnings of the republic and which cost us more in blood, treasure and needless war than anything else in our history.

The people of the United States want peace, and we look for some method of assuring ourselves not only of the continuance of the peace which we now enjoy, but more than that, for the acquisition of power to help promote peace in other nations. We want national defense not for war, but to promote more perfect peace. It was a soldier, William Tecumseh Sherman, who said: "The legitimate object of war is more perfect peace."

How are we to maintain that peace which we have long enjoyed, that peace which is the highest ideal of our national life and without which we can not preserve the free institutions which our forefathers fought to establish? How are we to help to promote peace in other nations without the strength to make our protests effective. The answer is national defense, or power to enforce peace. In other words, that power which inspires such respect for us in other nations as will forbid their attacking us. No truer words were ever spoken than these of Bayard Taylor's "Peace the offspring is of Power."

Up to a little more than a year ago we did not believe that such a war as is being waged in Europe to-day was possible. We had hoped that war between civilized nations was a thing of the past, but our hopes were suddenly blasted when the most enlightened nations of the earth were caught in the same passions of war as the veriest savages, less indiscriminately cruel perhaps, but just as blind in their frenzy of patriotic love and hate. These events have proved only too clearly that, no matter how highly civilized nations may appear to be, when their national safety seems at stake, or their national interests menaced, civilization and restraint are thrown to the winds, treaties and compacts are forgotten, whole races spurred by sudden savage hatred plunge headlong into war to the death with other races whom they hailed a short time before as friends and brothers. In the light of these facts, it is folly to say that war and aggression are things of the past, and that na-

tional humility and confidence in our own good intent, and in the high moral civilization of our neighboring nations, are sufficient guards against attack and disaster. We must profit by the lessons from the battlefields of Europe and not allow the futile and emotional cries of theorists and reformers for "peace, peace when there is no peace" blind us to the stern facts and realities which confront us and threaten not only our peace but our national existence.

A no doubt well-intentioned, but misguided, movement is being agitated among us which threatens to sap the strength of the nation and if not arrested bids fair to rob us of many of the sturdy qualities which are the mainstay of the republic. I refer to pacificism or the theory of "peace at any price"—a doctrine of absolute non-resistance. We must remember that we should not exist as a nation to-day if the men of '76 had believed in this theory. If carried to extremes it would amount to no less than treason in hours of national peril. When ordinarily sensible and high-minded people say to me that, even if an invader should approach our shores, we should let him enter and take possession, that we should offer no resistance, but allow him to violate our sacred liberties, I am lost in bewilderment at the kind of mind or soul which seems so lost to the fundamental instincts of self-defense implanted in the whole animate creation. Are we to put our faith in peace ships while the doctrine of brute force, the self-acknowledged creed of one great nation that "Might is Right" still stalks abroad in the world, leaving its trail of blood and death on the fair fields of Europe? Shall we put our faith in peace ships when the ships of militarism cross the ocean and train their engines of death on our defenseless shores? God forbid that any such sentimental folly should ever replace the spirit of America, the spirit that made us a nation, the spirit that actuated the men of Concord and Lexington and Valley Forge. To imagine such a possibility is an insult to the memory of those patriots who sprang to the defense of their home-land against tyranny and outrage; an insult to their brave wives and daughters and sweethearts who bade them go in God's name, and then did men's work at home that the nation might live. We see this spirit to-day in the women of France, yet there are those who dare to summon them to talk of peace in conventions, while their homes are burning and their land is devastated and their husbands and sons are slain by the ruthless god of "Might is Right." What they want now is not "peace at any price." They want the kind of peace that can never be broken again. Is pacificism likely to bring this about? Can pacificism stay the onward course of a triumphant militarism armed to the teeth? Could pacificism have helped Belgium in her hour of horror and need? Is it a man's part, or a woman's either, for that matter, to stand by idly theorizing, while the strong attack the weak, and treaties are proclaimed

to be naught but scraps of paper? What constitutes the binding force of a treaty in the mind of a nation that can so regard a treaty? Obviously nothing but a gun, since agreements and promises mean nothing. Insidious and secret war is already being waged upon us, a neutral nation, within our own borders by conspirators and spies to whom treaties and honor mean nothing. Our peace is threatened, our right to pursue our industrial interests undisturbed has been violated; our right to travel the high seas is denied; and American lives are sacrificed; internal disorders and lawlessness are instigated by the same power that trampled defenseless Belgium under foot. What are we going to do about it? After nine months of silence we uttered a protest against the slaughter of our citizens at sea and the violation of every sentiment of humanity and civilization. "What are you going to do about it?" was the reply, as plainly said as though uttered in words, and then the Arabic was sunk. We were told to keep off the high seas, where we have a right to go in pursuit of lawful business; we were told to keep from taking passage on ships of belligerents, even though they were innocent merchantmen, so that violations of international law and humanity might go on undisturbed. And pacificists would have us keep off, and continue the policy of polite letter-writing, while more innocent lives are sacrificed to the god of Might-is-Right. If we had had something besides ink to feed the power of Mr. Wilson's pen the results might have been different. But we had not and Germany knew it. "The pen is mightier than the sword" in all cases except—that of a scrap of paper. If human liberty, civilization and self-government go down to final death in the trenches of Europe under the assaults of militarism, will a defenseless pacificism save us from a like fate?

Pacificists tells us they do not mean disarmament, but they do mean that we should not increase our present total inadequate defenses.

Disarmament would be a splendid thing under certain conditions; it is what we all want; but to be effective it must be universal and simultaneous. We believe that through national defense this dream of disarmament will eventually come true. It is not true now, and until mankind reaches a stage of development that will admit of complete disarmament, our only safety lies in increasing our defenses.

There is no equality between one man armed and another man disarmed, and so it is with nations. Stable and equal conditions of peace can exist only between equally armed nations or equally disarmed nations, such as the United States and Canada. But between armed Europe and an unarmed America there is no equality and therefore there can be no security of continued peace. In the midst of the raging "sea of war" in Europe to-day there is what has been well named a little "island of peace." This is the wonderful little nation of Switzerland, respected, untouched, inviolate. And why? Because she is a

nation armed to the teeth—every citizen a trained soldier. She is equal to her armed neighbors, yet without standing army or militaristic methods. Opposed to militarism, on the one hand, as strongly as she is opposed to "peace at any price" doctrines, on the other, she nevertheless maintains herself in a condition of continued peace even in the midst of surrounding war. While we in America stand around theorizing, and talking of universal peace in conventions and sending out peace ships to ask the dogs of war in Europe please to let go of each other's throats, this little country has turned itself into a nation of soldiers through a system of voluntary compulsory military service—voluntary because the nation voluntarily chose to submit itself to this means of national defense. More thoroughly democratic than we are ourselves, they have nevertheless realized that compulsory universal service is their only guarantee of national independence, and they have had since 1874 a veritable citizen army, in which every able-bodied citizen is a trained soldier and not one, except the general and his staff, a professional military man. To an article in *The National Geographic Magazine* for November, 1915, I am indebted for these facts and for the following figures. With a smaller population than that of Massachusetts and an area twice the latter's size, Switzerland can mobilize 240,000 trained soldiers in twenty-four hours. At the same rate we could mobilize 8,000,000. Besides these men, the Swiss have as many more in reserve, so that under this system we could have in the field a trained army of 16,000,000 men within twenty-four hours. The founders of our country laid down the same idea of a citizen soldiery; the only difference is, the Swiss have put it into serious practise, while we theorize and make laws which we never enforce. In principle, every citizen is supposed to join the militia. Does he? And how many Americans know how to shoot to hit the mark, or have ever handled a gun? As a sharp contrast, the Swiss boy begins at ten years of age to take the gymnastics that fit him for military training, and he learns how to shoot like William Tell—substituting bullets for arrows. Every man cheerfully sacrifices a definite amount of his time toward the maintenance of the one thing dear to every Swiss—as to every American—his independence as a citizen of a free country, and the amount of time is exceedingly little. During the first year of liability to military service at the age of seventeen, he gives up seventy-five days, but only eleven days in each successive year.

His training is in the field, not in drill rooms, and he spends less on military taxes than any other nation. The burdens of preparedness are thus spread over the whole nation, and lie heavy upon no one individual. There are no "crack" regiments; no picking and choosing in the service. Each man goes where he is sent and can serve best. There is no caste system. Brains and ability win the high places;

all start from the ranks. Our militia system has much to learn before it can be compared with the Swiss citizen army of defenders—for defenders they are. Not one foot of territory do they wish to acquire. Not a blow would they strike in aggression, but let him who strikes at them beware what he does! This is the ideal of national defense, which is the inalienable right of every man, of every woman, of every nation to defend itself against attack. Herein lie self-respect and a national dignity impervious to insult, because it is above insult. "Though surrounded on all sides by belligerent millions" (to quote from the aforesaid article) whose interests might be served by asking her to step out of their path, Switzerland to-day stands an island of peace in a sea of war, because she has prepared to maintain her neutrality and her freedom, or at least to exact such a price for them that none of the nations at war can afford to pay for their violation." What an object lesson for us. While in a country so large as ours it would be the height of folly to give up our regular standing army—say rather, it should be increased—it ought to be practicable to so remodel our militia as to approach nearer to the wonderful efficiency of the citizen army of Switzerland. If to such an army we would but add an adequate navy and sea-coast defense, we should be invincible. This would not militarize us as a nation; it would train us simply in efficient self-defense, whereby alone we can inspire, respect and maintain peace and liberty.

Therefore to secure peace for our own country in years to come a policy of strong national defense is necessary until such time as the probability of war is reduced to much below the present ratio.

We believe that it would be just as unwise for the United States to allow its army and navy to deteriorate, as it would be for a householder to allow the fire-insurance policy on his house to lapse because he disapproved of fires and hoped there would be no more of them! One of the fundamental laws of our government—of any government—is the protection of persons and property and it should be our national resolve to be strong enough to protect the weak from the aggressions of the powerful who are also unscrupulous, and the innocent from the violence of criminals, whether individuals or nations.

It is not sufficient that this country should merely defend its own citizens; it must, as it did in those first years of the nineteenth century, take its share in the burdens of maintaining law throughout the world. "Man lives not to himself alone" is as true of nations as of individuals. Government is organized defense of others. The nation that will not protect its citizens at home and abroad has no right to the name of nation for it lacks the essentials of government.

One reason why Americans have a right to be proud of their nation's history is that in the earliest days of its life, when its population was

small and its resources limited, the United States showed itself willing to sacrifice blood and treasure for the protection of the rights of its citizens. Against England in 1812 it set itself for the sake of defending the freedom of the sea.

Still earlier in its history, when it had many domestic difficulties to contend with, it undertook to rid the Mediterranean of the Barbary pirates who infested it. You know the results. Should we not now, when we are large and rich and strong, protect our own citizens on the high seas and be able to take our share in the burdens of maintaining law throughout the world? It is a plain duty that we should; and if we are to take our full part, we must have the means by which to take it. The disorderly and lawless are not quelled by words or diplomatic notes. We must have some method of establishing justice and some means of defending justice with arms. The American people must not be content until this nation is fit to take part in the world's work, and all patriotic Americans should unite in insisting that we have adequate national defense. As descendants of the patriots of the American revolution, we owe a distinctive duty to our country to uphold our institutions and our national dignity and to stand ready at all times with the spirit of highest patriotism to guard and protect our rights and privileges and that liberty for which our ancestors fought. National defense was the keynote sounded by Washington when he said "To be prepared for war is the most effective means of promoting peace," and he further said:

> There is a rank due the United States among nations which will be withheld, if not absolutely lost, by the reputation of weakness. If we desire to avoid insult we must be able to repel it; if we desire to secure peace, one of the most powerful instruments of our rising prosperity, it must be known that we are at all times ready for war.

Another patriot, Charles Pinckney, voiced the same spirit of defense when he said:

> Millions for defense but not one cent for tribute.

President Wilson expressed his views on national preparedness a few weeks ago, when he said:

> I would not feel that I was discharging the solemn obligations I owe to the country were I not to speak in terms of the deepest solemnity of the urgency and necessity of preparing ourselves to guard and protect the rights and privileges of our people, our sacred heritage of the fathers who struggled to make us an independent nation. Come, let us renew our allegiance to America, conserve her strength in its purity, make her chief among those who serve mankind, self-reverenced, self-commended, mistress of all forces of quiet council, strong above all others in good will and the might of invincible justice and right.

The war in Europe to-day has awakened in us a new realization of the profound truth of these words I have quoted from Washington, our

first, and from Wilson our latest president. To defend the heritage of our fathers is a sacred duty. The spirit of our fathers calls us like the minute men of old to our country's defense. Not in weakness, but in power lie the foundations of that continued peace which is the highest ideal of a true, loyal and enlightened patriotism.

IMMUNITY OF MONUMENTS, MUSEUMS, LIBRARIES, ARCHITECTURAL AND HISTORICAL STRUCTURES IN WAR AND PEACE

By GEORGE FREDERICK KUNZ, Ph.D., Sc.D.

CHAIRMAN OF THE SECTION OF ECONOMIC AND SOCIAL SCIENCE OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, PRESIDENT OF THE AMERICAN SCENIC AND HISTORIC PRESERVATION SOCIETY

ENCOURAGING advances have been made in the United States and in foreign countries in the preservation of natural and architectural landmarks in time of peace, but the events of the European war which began the summer before last have emphasized in a painful way the need for some international agreement which will secure the immunity of historical monuments, museums, libraries and works of art generally in time of war. If the civilized nations of the world have not yet so far outgrown their primitive passions as to be able to settle international differences by means other than slaughter and destruction, it would seem practicable to mitigate at least the losses of war by preserving historical monuments, cathedrals, civic buildings, libraries and works of art. The existence of these in no way affects the fortunes of war, but their destruction robs civilization of the evidences of its progress, obliterates forever the products of the genius of former generations, and causes the animosities engendered by the war to rankle in the hearts of men for generations to come.

In any war, the greatest destruction in these respects is naturally inflicted in the country invaded and by the invaders. People do not destroy their own treasures if they can help it. It therefore happens that in the present European war, Belgium and France have been the chief sufferers, and in a lesser degree the Polish provinces and even England. But it is not intended by this statement to imply that the invaders in the present case are more ruthless than other nationalities have been in the past. In the conflict between Italy and Austria, the destruction of Görtz or Goritza, and the damage done by bombs in Venice offer a sad reciprocity in the infliction of useless injury.

The history of the famous Alexandrian library is sufficiently polyglot in this respect. Part of the library—the largest in the ancient world, embracing the collected literature of Rome, Greece, India and Egypt—was destroyed by fire during the siege by Julius Cæsar. Another

part, kept in the temple of Jupiter Serapis, was largely destroyed when Theodosius the Great permitted the Serapium to be demolished with all other heathen temples in the Roman Empire, A.D. 391. What the Christians left, the Arabs, under Calif Omar, obliterated in 641. Of the books in the Alexandrian Library Omar is alleged to have said:

> If these works agree with the Koran they are unnecessary, if they disagree they are heretical; therefore let them be burned.

Diocletian's destructive inquisition in the east left few Christian books for Constantine to collect at Byzantium; and after the inroads of the barbarians into the Roman empire, the ravages of fire and war had destroyed practically everything that could be called a library.

The burning of the Arabic manuscripts in Granada by Ximines, and the holocaust of the colored picture writings of the Aztecs in Mexico by Zumarraga, obliterated irretrievably valuable records connecting modern and ancient history.

The almost total destruction of Heidelberg by the French troops in 1639 and 1693, with the loss of many literary and art treasures, and the destruction of the valuable public library of Strassburg during the German bombardment in the Franco-Prussian war of 1870, are more modern illustrations of the fact that the ravages of war in this direction have not been confined to any one nationality.

The present is not an appropriate time to review the destruction caused by the European war now raging. When the war has ceased and the field has been surveyed, so that the facts can be accurately ascertained and dispassionately judged, we shall know the true measure of what Liège, Louvain, Rheims, Whitby, and other places have suffered and what art, letters and history have lost in the making of a new epoch in the history of human events.[1]

It is sufficient now to call attention to the public sentiment in favor of restricting this destruction and to express the hope that measures may be taken to prevent it in the future.

At a meeting held at the National Arts Club in New York City on December 4, 1911, the president of the American Scenic and Historic Preservation Society said:

> The destruction caused by siege operations when not controlled by the stipulations of an international agreement to protect those treasures of art and literature which should be regarded as international property, since the enjoyment and use of them is freely accorded to all, natives or foreigners, who may wish to avail themselves of the privilege, has been only too often demonstrated.

[1] At a meeting of the German Metallurgists at Düsseldorf, held in February, 1915, Dr. Schuster, speaking of the lack of copper, zinc, and other metals needed in the manufacture of war materials, suggested that the authorities should commandeer, not only in Germany but also in Belgium and France, all available metals from the brass water tap to the copper roofs on the churches, including in the perquisition all bronze monuments.

If, at the next meeting of the Hague Tribunal, an agreement is reached by which libraries and museums will always be exempted from destruction during a war, one great source of danger to the records of history will be removed. It would be most desirable that some such international agreement should be made in regard to the preservation of libraries or museums from wanton destruction in the case of the bombardment of a city. Would that an international understanding of the kind had existed when the Alexandrian library was in jeopardy! Indeed, even as recently as the Anglo-Egyptian war of 1882, the existence and enforcement of regulations for the protection of valuable records might have saved untold trouble regarding land titles, caused by the loss or destruction of legally recorded documents.

During the past year the American Society for Historic and Scenic Preservation has brought this subject to the attention of the Secretary of State of the United States, in the hope that steps might be taken to lessen further losses in the present war, and to pave the way for more effective measures in the future.

In furtherance of this idea, the president of the society has designed a flag to be displayed over churches, libraries, museums and historical monuments, for the purpose of securing for them immunity similar to that which hospitals enjoy under the Red Cross flag. This flag, having a width equal to two thirds of the length, consists of a white field, with a diagonal colored stripe running from the upper corner at the hoist to the lower outer corner, the stripe being in width equal to about one third of the width of the flag. By the color of the diagonal stripe the nature of the protected building may be indicated—red, for instance, signifying a museum, blue a library, etc. Specimens of this flag were displayed at a public meeting of this society held in the American Museum of Natural History in New York City on January 13, 1915.

Action along similar lines has also been taken by the American Institute of Architects and by the Architectural League of New York, as well as by the National Sculpture Society, which has addressed a direct and eloquent appeal to the European belligerents.

A despatch to the London *Daily News* from Brussels, in August, 1914, reported information received from M. Paul Otlet, president of the Union des Associations Internationales, that a movement was on foot to induce the United States to obtain the cooperation of the neutral powers of the world in approaching the belligerents to beg them to respect museums of art and scientific collections in the threatened capitals. He mentioned, for instance, that in Brussels were the plates of the photographic map of the heavens. It has taken twenty years to complete the work, and the destruction of the plates would be an almost irreparable loss to the world.

In September, 1914, the diplomatic representatives of neutral countries asked the Hon. Myron T. Herrick, United States ambassador to France, to sound the American government on the question of making

joint representations to Germany to protect certain buildings and works of art in the event of an attack on Paris.

And from a cablegram to the New York *Times* from Rome, dated January 23, 1915, we learn that, before Italy's declaration of war, a group of well-known Italians addressed a letter to Secretary Bryan conveying an appeal that the United States take some action to the end that the monuments of art in the belligerent countries be preserved from ruin. It was the expectation of those who were launching this movement that it would find support in other neutral states, particularly in Switzerland and Spain. The letter was signed by Bestolfi, the well-known sculptor; by Aristide Sartorio, the painter, and by Giacomo Boni, the archeologist, and said in part:

> The art treasures in these countries must be considered as part of the patrimony of the civilized world, and not as the particular property of any country. If all great artists and influential people throughout the world join in this movement much may be done to preserve these art treasures which otherwise will suffer irreparable loss. We look toward the United States as the nation which today, better than any other, can undertake this task and see it through to a successful accomplishment.

In conclusion the writers asked Mr. Bryan to call the attention of the president to the matter.

It is much to be regretted that the regulations adopted by the delegates to the last Hague convention, were not officially ratified by all the governments represented there, as in that case we should have a few hard and fast rules to appeal to, rules which the several nations would feel bound to respect as matters of international law, and not merely of international comity. For the latter, although often operative in time of peace, is but a weak reed to lean upon in time of war.

However, no agreement entered into by the nations to refrain from the destruction of historic monuments and art treasures can ever be of avail unless it be at the same time clearly and definitely understood that such monuments must be equally respected by both belligerents. When this is not the case, when the defenders have yielded to the temptation of utilizing an edifice for military purposes, for signalling or observation, or for masking their artillery, the responsibility for any injury must rest on their own shoulders.

How essential this is has been illustrated by the havoc wrought in the Parthenon through the explosion of powder stored therein by the Turks, during the siege of Athens by the Venetians in 1687. The knowledge that this unique monument of art was being made use of as a powder magazine caused the Venetian fleet to fire upon it, an act that would almost certainly have been avoided otherwise, but one that was quite justifiable under the circumstances, although eternally regrettable. Until that time, this great edifice, erected by the architects Ictinus and

Callicrates in the Age of Pericles, two thousand years before, was still essentially intact.

The thunderbolts of war are not the only perils to tall buildings or lofty columns, for those of nature are chargeable with a number of disasters. At Santamaria di Capua Vetere, in the province of Caserta, Italy, a high column of travertine marble set on a firm pedestal of the same material and bearing a bronze statue of Victory about ten feet high, weighing 1,500 pounds and affixed to the column by an iron rod, had been erected as a memorial of the battle fought near Volturno in 1860. This monument, about 95 feet high, stood in the quadrangle of the communal building and no trees were anywhere near it; nevertheless, on an October day in 1914, during a severe thunderstorm, a bolt of lightning struck the massive statue, hurling it to the ground and breaking away the upper half of the supporting column.[2] It is believed that had a metallic conductor been passed down from the bottom of the iron rod to a damp sub-soil, the electric discharge would have been carried into the ground, instead of spending its fury on statue and column. The insulating mass of marble afforded no protection, but rather constituted a danger.

In the Constantinople of the Eastern Empire, two columns were wrecked in a like manner, one in A.D. 548, and another, commemorating Constantine the Great, in 1101. A similar fate threatened the column of Marcus Aurelius Antoninus in Rome, when it was struck by lightning in the fourteenth century, but escaped with severe damage to the top; while in the same century the statue of Trajan at the top of the Trajan Column in Rome was destroyed by an electric discharge. In ancient Rome the Baths of Nero, erected in A.D. 60, were destroyed by lightning in the following year. Coming down to the Rome of the Renaissance, the bronze statue of the Archangel Michael on the Castle of St. Angelo, to which it gave the name, and the flagstaff there, were wrecked by lightning in 1572, and from 1606 to 1809 St. Peter's was struck no less than twenty-two times, but no great material damage was ever done. After the last accident Pope Pius VII. had lightning rods installed and for the past century they have proved efficient protectors for this greatest of Roman Catholic churches.

Of other Italian edifices destroyed by lightning, the following towers may be noted: in 1521, that of the Castello of Milan; in 1676, that of Ivren; in 1769, that of San Nazaro at Brescia, and in 1808, the tower of the fortress on the Lido opposite Venice.

The protection afforded against the thunderbolt by the lightning rod may be assimilated to that given by a binding international agreement

[2] This and the following instances of monuments and buildings struck by lightning are reported in a memoir by Professor Ignazio Galli published in the *Atti della Ponteficia Accademia Romana dei Nuovi Lincei,* Dec. 20, 1914.

against the devastating projectiles hurled from the huge guns, the products of human ingenuity and industry. It is to be hoped that when the storm of war has passed away and the nations of the world are again able to take up their interrupted march toward the goals of social, scientific, artistic and industrial progress and aspiration, the terrible lessons taught by the war will not have been learned in vain, but will serve as incentives to provide adequate safeguards for the future. If, as we scarcely dare to believe, an era of peace and good will follows the close of the bitter conflict, the action in common for the preservation of the historic and art treasures of the world will help on the good work.

PREPAREDNESS—SOME SUGGESTIONS

By ARTHUR WILLIAMS

NEW YORK CITY

THOSE interested in the preservation of that which connects us with the past in art, literature and architecture, look upon the unnecessary destruction of the museums, churches, monuments and historical structures, that is being wrought in Europe, with a degree of regret and horror which can not be easily expressed. Loss of such buildings as the Hôtel de Ville at Louvain, the Cloth Hall at Ypres, the Hôtel de Ville at Arras, such a marvel of architecture as the Rheims Cathedral, or the destruction of such valuable manuscripts and volumes as those housed by the University at Louvain, are calamities to be lamented in the conservation of art and learning. In New York City alone, who could measure the damage resulting from the destruction of such buildings as those of the American Museum of Natural History, the American Museum of Art, the American Museum of Safety, the New York Public Library and many others? Every one must view with apprehension any condition through which our educational and historical structures would be the subject of possible destruction through the attack of an enemy. This would be particularly so if that calamity should be the result of evident unpreparedness, after all the warnings we have received through the conditions existing in the countries now at war.

A program which is distinctly confined to the defensive side of warfare is not necessarily one which would be immediately capable of an effectively offensive campaign. That is to say, the essential elements in a defensive program, where the clearly defined objectives are defensive, do not necessarily equip one for effective offensive action. Preparation for defense could be utilized for an offensive, and places material at our disposal for an offensive movement much more quickly

than were we without our defensive preparation. But the two objectives are opposed to each other and simply because our country places itself in a position for an effective defense is not a reason to fear that we would more readily be apt to give offense to others or become here, as was the case in Europe, an "armed camp" and a nation of "military men."

Our entire attitude should be one of effective defense, on both land and sea, of each of the states, of our foreign possessions, so long as they remain under our control, and in addition should afford adequate protection to our citizens abroad. The present conditions in Europe show that any failure on our part to provide adequate defense would be most short-sighted and wholly inconsistent with the demands of the country. This is probably the feeling of the great majority of the American people. The conviction can be little short of unanimous that in the last analysis behind any treaty or agreement we must have a military and naval organization of a defensive character that could adequately meet the offensive from any probable or possible enemy or combination of enemies.

Adequate military preparation takes years. This is true not only of ships, guns and other machines, but of human beings, upon whom to the last degree the result must depend. Preparation must include ships of varying degrees, arms and munitions, clothing, housing, equipment and the fullest needs of the commissary and the medical departments. Some of the preparation may consist of a latent ability to produce quickly and well; some must consist of an existing equipment in all of these departments ready for practically instantaneous use.

The seventeen years that have elapsed since the Spanish war have at least partly eliminated some of the lessons of that war. Very few understand the extent to which we were unprepared, even for a power so relatively weak as Spain. Our lack of material then went even so far that the authorities were without cables to mine our harbors, or mines to protect them, or explosives with which to charge the mines. We were without a need so fundamental as search lamps; the government had none, the manufacturers were out of supplies and it was necessary to secure the promise of a loan of such lamps from those who had them. We were without equipment in our commissary departments and the ultimate provisions even were a blot upon the administration of the country; and as for sanitation, even of the most elementary character, no such thing was known in any practical sense.

We were without men for our forts, without men to instruct others how to operate our coast defenses. The available trained men of the army were but a handful, and hundreds or thousands were needed where but one was available. Had our war been with one of the first-class powers, many of our coast cities would have been destroyed and landings could have been effected. That our nation would be conquered by

any country, however great, is not to be supposed for a moment; but that vast properties would be destroyed and hundreds of thousands, if not millions, of men "killed, injured or missing" included in our daily lists before a satisfactory result could be reached, would have been then part of the price of foolish unpreparedness, just as it would be part of the price to-day.

Many plans have been proposed and probably upon no plan do all minds meet. About an adequate navy there seems to be no difference of opinion, except possibly in the definition of the term "adequate." Unless we have a navy equal to that of any other country with which we may be at war, naval equality will be an impossibility, and, dealing with a superior force, certainly, in the absence of miracles, we must concede defeat at sea. Nothing is gained by assuming a strength we do not possess. If our navy is inferior to that of England, the English in the event of war could obtain the supremacy of the seas and our sea commerce would cease. This would be a serious matter only from the standpoint of retaining our foreign possessions and of protecting our commerce. The determining factor here would seem to be whether the country wants to go to the expense of being at all times reasonably sure of holding its possessions and of protecting its sea commerce. Apart from the question of patriotism and national pride, does the one equal the other? In the absence of such adequate provision, we could retain our foreign possessions and our sea commerce only so long as another nation with its own navy, or a combination of nations with their navies, permitted us to do so.

Apart from this question of size, all will agree that the country should possess an adequate navy, whatever may be accepted finally as the definition of this term. Such a navy should include dreadnaughts and super-dreadnaughts, at one end of the line, and submarines and transports, at the other end. One of the lessons of the Spanish war was the necessity for transports and one of the serious difficulties for a time was that of transporting equipment, munitions and men. Transports—a term which here is used as being inclusive of colliers for coaling our vessels at sea or at distant points—may be obtained either through a fleet maintained solely for that purpose by the government, lying idle and depreciating rapidly in times of peace, or by the upbuilding of a large merchant marine through private resources, as in England, which would be immediately available for the needs of the government in the event of war. Those who were in England when the war first broke out will appreciate far more than can those who remained at home, the enormous value of having a large merchant marine immediately available for transport and other service. Of course, the regular service of passengers and their baggage was interrupted, but this counted little, in comparison with the disadvantages of carrying for years a great unused

fleet of equal size, and the consequent commercial interruption was one which in any event would have occurred very largely as one of the results of the war.

The defense of our homes and our country is essentially different, however, from the defense of our foreign possessions or the protection of our commerce. Here our very liberties would be at stake and our entire population, instead of a small percentage, would be endangered. And if this larger percentage were sacrificed the smaller would follow, whereas if the smaller were lost for the time being the preservation of the larger would eventually care for the smaller. Adequate defense begins probably with the mining of our harbors and our shore defenses. These would prevent destructive attacks and landing. Behind these should be available for immediate use an armed force of moderate size and behind this a force capable of being quickly mustered and armed, of practically unlimited size in reference to our population. It is conceivable that the time may come when every one capable of bearing arms will be called upon for defensive action.

The operation of large and small guns in the fortifications and the planting and control of mines calls for a minimum force technically trained and capable of instructing others who in the event of emergency would be enrolled for their assistance. An organization should be maintained at all times sufficient to man our fortifications at a minimum and sufficient to instruct any numbers added for the adequate operation of the defenses, however long an offensive attack might continue.

While the effectiveness of the submarine has been more fully demonstrated than ever before, some question remains concerning its relative value. About mines, however, as an element of defense, no question can exist. We have yet to hear of the failure of any mined defense.

Another technically trained force maintained at a minimum and in constant service should be that necessary to operate a fleet of aerial craft of all the types which have been shown to be effective during the present hostilities. Some doubt may remain at the moment as to the effectiveness of aerial attacks upon fortified places, but no question would seem to exist concerning their indispensability as a means of reconnaissance and for guarding against an enemy's attacks from the air. It is perhaps no exaggeration to say that without aerial defense such a city as Paris could be wrecked by the bombs of an enemy dropped from flying machines. A permanent corps capable of immediate and effective action and of instructing others on a greatly broadened scale, should be in the constant service of the country.

Automobiles, for transportation and for carrying warfare directly into the lines of the enemy, are increasingly important as military factors. This is another field in which the country should have adequate reserves available for immediate use and producing capacities

which would insure a supply, full and adequate, on very short notice. The standing force devoted to this purpose need not be so large relatively as that for defense, but the technique should be understood and the means of quick development should be always at the disposal of those in charge of our government.

The manufacture of guns and explosives perhaps falls into two classes. For the normal needs of commerce and the government it might well be that to a large extent, if not entirely, these supplies could be obtained from private manufacturers. Their capacity for manufacture and delivery would be a factor in preparedness. Behind this capacity and supplementing it, the government should be at all times prepared to manufacture equipment and explosives. This capacity for manufacture could probably consist of instructors and machinery, with a minimum of those technically informed in the work—one of those national resources or reserves of no value in times of peace, but of paramount importance in the event of war.

It is essential that we have a commissary plant capable of providing full service to a minimum of from half a million to a million men. That is to say, the mobilization of that number of men should be accomplished with an equally rapid mobilization of equipment and supplies necessary for their shelter and food. Behind this we should know that we have plant-capacity for turning out added equipment as rapidly as men could be mobilized, so that at no time should even a single company of soldiers go into camp or into the field without adequate commissary always within reaching distance.

Equal precautions should be taken with regard to the sanitary side of camp and trench life. Materials required should be immediately available for a minimum force and all the essentials should be so well understood that adequate sanitary provision would be made for every group of men the moment they are mobilized and put into active service. Never again should we have the blot of Tampa or Montauk Point on our military activities.

Chemistry is playing a part in this war which was heretofore unsuspected. For years, even before the Spanish war, it has been understood that the machine and the engineer would be great factors in modern warfare. But the chemist was given a place altogether too unimportant. All that is known in the use of and protection against poisonous gases or any other similar means of offensive action should be at the disposal of our authorities and all that the future may reveal should be placed immediately at their disposal. We should never go into action handicapped by a lack of knowledge concerning the offensive or defensive possibilities of explosives or chemicals or gases. Ignorance is no excuse for wounded, blinded or dead men, or for a defeat.

Individual equipment of each man for active service is another ele-

ment for which careful provision should be made. If we have a standing army of a quarter of a million men, its equipment would naturally be always at hand. And so for the additional army or armies which might be required to meet an enemy, equal equipment, individually complete, should now be provided. If we think a million men should be ready on short call for adequate defense, we should have a million complete equipments ready for instantaneous use for man and horse. In being thus prepared, we would be saved such pathetic sights as young men in civilian clothes marching up and down the streets of London or drilling in squads in the public places and parks, in their civilian clothes, carrying wooden sticks, to imitate guns, and other articles bound together to represent about the average load of a marching soldier. A minimum equipment should be immediately available and the means for providing enough additional equipment as men are assembled should be always at the service of the government.

Behind all this lies the preparation of the human machine, which to any needed extent should be capable of immediate assembly. The problem is how this is to be attained without turning our country into an armed camp or leading us to a distinctly military existence. The only way to secure this result would seem to be through the education of our older boys and our young men, say, between the ages of fourteen and twenty, in the elementary features of military life. These should include shooting and a knowledge of handling small arms; of marching and of living in camps and in trenches; of so approaching and retreating from an enemy as to make the most of either artificial objects—such as "digging in"—or natural objects for self-defense; of camp and trench life, including cooking and the elementary features of camp sanitation. The objective of this training would be to have the vast and growing body of men, who, with little more training than that necessary to fit them for the open, would be immediately available for any protective effort against the attacks of an enemy.

It would seem that this training must be conducted in such a way that it will reach every growing boy and will place at his disposal every means of acquiring this kind of information now at the disposal of our state and national governments. The present method of training state militia, whereby men can enter the regiments only by some form of social selection, and there remain year after year long after their periods of usefulness have expired, is obsolete and calls for early discardment. As a substitute, our armories should be open to all, exactly as our schools are open to all, and their use to any one individual should be limited to a certain period of time, say, one, two or three years, within which the necessary military training could be obtained. If it were two years, the second term men would be available for military service; or if

for three years, the third term men, supplemented by the second or first year men, in the event of emergency, as the circumstances might justify.

Probably the men who have seen even the smallest part of camp life or military service are the best safeguards we have against war. Those who merely observed the results of the early days of the war in Europe would do all that lies in their power to prevent a repetition of the European conditions in our own country. If this be true, this form of training, added to the hardships of camp life and military service, would seem to act as a deterrent and not an incentive towards war.

Military training leads to better physique and better physical condition; it adds a degree of discipline, which many observers think would improve our American standards; it is a desirable kind of education; it improves personal hygiene; it undoubtedly leads to higher standards of health and of living.

The subject is one which should be approached calmly and without hysteria. The lessons of the Spanish war and the conditions prevailing in Europe, however, warn us that adequate defense preparation is essential and that no time should be lost. Those who represent our government should take the country into its confidence, they should proceed broadly and, in this, eliminating all politics, may expect the unanimous backing and support of the country.

We must have a plan which will include a knowledge of what we have got, of what we can get, to what extent and in what time. It must include technical organizations, each complete with a minimum of equipment and trained men. It should include the best possible combination of government and privately owned resources for all purposes, from an adequate fleet of both a primary and a secondary nature to the provision of munitions, and equipment in any required extent. Distinction is made between an active and a latent producing capacity; the two should be separately considered, the plan of each effectively accomplishing its intended objective. And, finally, whatever may be the method adopted, we must have an unlimited citizen-reserve capable of getting quickly on the firing line, and behind this a reserve backing up those on the firing line without delay with every detail perfected of efficient and modern supplies.

Perfection of such a plan and organization would prevent rather than encourage us in seeking differences with other nations and would give us that degree of preparedness which is called for in the defense of our country, our institutions and our homes and the lives of our women, our children and our non-combatants.

PREPAREDNESS

By the Honorable JOHN Q. TILSON

House of Representatives

In view of the fact that I am a member of the Committee on Military Affairs of the House of Representatives, which is charged with the duty of investigating the subject and formulating a plan for the proper organization of the land forces of the United States, it will not be wise or discreet for me to attempt to state just what the plan should be. It has been announced that the question is to be considered on non-partisan lines, as such subjects ought always to be considered, and this is an additional reason why I should not attempt to prejudge the case. There are, however, a few broad, general propositions which must be at the basis of any effective and permanent preparation.

In the first place, there must be a sufficient number of trained men to fill up our first line of defense. Their training need not be of long duration, but should be intensive enough to teach discipline, the use of firearms and the care of self in camp or campaign. It is better that these men be trained citizenry, rather than trained soldiers only. There is no more reason to fear militarism because of this than there is to fear that a boy will become a prize fighter because he keeps a sound body and is taught the manly art of self-defense. Some such system as that so successfully used in Switzerland and Australia would be effective here if it could be adopted and maintained long enough to get results. We must not be blinded, however, to the inherent difficulties in the way of the adoption or carrying out of such a system. Something, however, should be done and if the people of the United States are not ready to adopt universal citizen service, then in addition to our regular army and National Guard both of which should be somewhat enlarged, we should have a voluntary, but paid, reserve.

I have said that our regular army should be somewhat enlarged. This is absolutely necessary and seems to be generally accepted as one of the changes sure to be made in the near future. Even as a school for military training, the army at present is not large enough, and, while I do not believe that a large standing army is necessary, and should be opposed to the enlargement of the army comparable to those of European countries, still I think a very considerable enlargement is wise and necessary.

The navy should, undoubtedly, be gradually increased and the lessons of the present war in Europe should be carefully studied and applied in the addition of submarine and other auxiliary craft. Aerial navigation has greatly changed modern warfare and must receive immediate attention in both the army and navy.

Better industrial organization is also one of the necessities of an

adequate national defense. In the development of our resources, every man has gone too much his own way, so that there has been no effective coordination of our industries with a view to national defense. Every manufacturing establishment, great or small, that can manufacture arms, war munitions or any kind of war equipment, or that can be readily adapted to such use, should be catalogued and organized. In fact tentative contracts might be prepared and entered into between the United States government and manufacturing establishments to be effective only in case of invasion, war or imminent danger thereof.

Transportation should be organized in the same way in all its branches, including our railroad companies, steamship lines, our motor industries, especially trucks, and even down to business wagons.

There is one other general matter that I hesitate to speak of because it is generally considered a partisan question, but, as an avowed protectionist, I do not believe that it should be a partisan question. This is adequate protection for American industries, especially those concerned with the production of materials necessary in time of war. The aniline dye situation at the present time is a case in point. Our country has deliberately adopted a policy disregarding this industry and has encouraged the dependence of this country upon foreign producers of these goods. We now find ourselves hampered in our textile industries and in some instances a complete demoralization of business for lack of dye stuffs has occurred. Worse than all is the fact that the most effective explosives are those made from the same materials, so that we are to-day in a state of complete dependence upon a foreign country for materials essential in case of war. True, we have an abundance of raw material, but it would require valuable time and large expense to develop the industry under war conditions.

These are but examples mentioned by way of suggestion, but they seem to point the way toward the most effective kind of preparation, either for or against war, as the case may be.

While the present struggle in Europe has brought the question to the attention of many who before had been indifferent, to my mind it has not changed the problem so far as the United States is concerned, except in the details.

During the sixty-second Congress, while serving my second term there, I gave considerable thought to the question of preparedness, although it was not known by that name at that time. I introduced a bill providing for the beginnings of a trained national reserve for our land forces and presented to the House of Representatives facts and data in support of it. At that time, however, such a proposition fell on deaf ears, and the only change that was made, and that over my strenuous opposition, was the adoption of the absurd seven-year enlistment period, which has proved an utter failure; so far as providing an adequate reserve is concerned.

I do not believe that the danger of war is any greater for the United States now than it was three years ago. Neither do I believe that our need for an adequate national defense is greater than then. We needed it then, we need it now, and shall continue to need it until we face the problem squarely and solve it. We can not afford to go on taking long chances, as in the past. I hope something worth while will be done while the people are interested.

There is, however, a great danger of plunging headlong into an extreme course. It would be easy for us to roll up an enormous national debt for a kind of preparedness that would prepare us for the moment only and leave behind a heritage of debt and dissatisfaction that would soon neutralize the effect of all our preparation. A well-laid plan, covering a period of years, capable of enlargement or possible curtailment, if changed circumstances should make it wise, is far more to be desired than huge expenditures, rashly made, for preparedness that would soon cease to be effective.

AMERICAN EXTRAVAGANCE A NATIONAL PROBLEM

By EDWARD A. WOODS

PITTSBURGH, PA.

> Great Nations and great Empires only live so long as they are thrifty; the moment they begin to waste or disperse their resources, the day of their end is at hand.
>
> —*Lord Rosebery.*

ILL-GUARDED, great wealth is tempting. If recently and suddenly amassed, made from those tempted to appropriate it, through the loss of their own trade, it tempts more; but it is greatest of all if those possessing this wealth are known not to possess the sturdy strength to defend it.

Nor must this strength be measured exclusively by an army and navy. Back of these lies the moral, physical and financial strength of the people. Effeminate, extravagant, prodigal nations, even if civilized, large and rich, have ever been the prey of strong, sturdy, frugal ones. So the rich east was a prey to the semi-savage Mohammed hordes. So was wealthy, effeminate Byzantium to the rough northern crusaders. So was wealthy, luxurious Rome—the mistress of the world—to barbarian Goths and Vandals.

Britons were angry at Kipling's message from South Africa, trying to shame the people of Britain because:

> Ye set your leisure before their toil, your lust above their need.
> When your strong men cheered in their millions, while your striplings went to the war.

and at his famous reproach to sporting England:

> The flanneled fools at the wicket or the muddied oafs at the goals.

But Americans and Britons alike may read "The Islanders" with a different feeling to-day, when he speaks of:

> Life so long untroubled, ye who inherit forget
> It was not made with the mountains, it is not one with the deep.
> Men, not gods, devised it. Men, not gods, must keep.

Parkman, in closing his wonderful history of the French and English conquest of America, says:

> Those who in the weakness of their dissensions needed help from England against the savage on their borders have become a nation that may defy every foe but that most dangerous of all foes, herself, destined to a majestic future if she will shun the excess and perversion of the principles that made her great; prate less about the enemies of the past and strive more against the enemies of the present, resist the mob and the demagogue as she resisted Parliament and King; rally her powers from the race for gold and the delirium of prosperity to make firm the foundations on which that prosperity rests; and turn some fair proportion of her vast mental forces to other objects than material progress and the game of party politics. She has tamed the savage continent, peopled the solitude, gathered wealth untold, waxed potent, imposing, redoubtable; and now it remains for her to prove, if she can, that the rule of the masses is consistent with the highest growth of the individual; that democracy can give the world a civilization as mature and pregnant, ideas as energetic and vitalizing, and types of manhood as lofty and strong as any of the systems which it boasts to supplant.

Wastefulness, extravagance and prodigality undermine the entire mental, physical, financial and moral fiber of the nation. Do they tend to make America such a nation as those New England farmers who resisted strong and wealthy Great Britain nearly a century and a half ago? With nations, as with individuals, the period of wealth is generally a period of decay, of sloth, and of the weakening of moral fiber. Can America, possessing one fourth of the wealth of the world, feel that the mere possession of wealth brings security, instead of an opportunity to others? Is it not the frugality of sturdy little Switzerland that enables her to keep out of the maelstrom of war that envelops her on all sides? Would France not long ago have succumbed, had her people, instead of being thrifty and provident, practised the luxury and extravagance of the United States? Will it not be the thrifty, frugal people of Germany, France and England who in the long run stand back of and support their governments in the great conquest over-sea?

It surely needs no argument to any careful observer to show that great wealth, particularly if quickly acquired, does not make for character in the individual. With it come luxury, waste and extravagance, and these are not character-building but character-undermining qualities, making the one who acquires wealth, and still more his descendants, luxurious, effeminate and neither frugal nor industrious. The same

thing is true of nations, for nations are but aggregations of men. In a comparatively short time America, young as nations go, has acquired over $188,000,000,000 of wealth, equal, if a few European countries are excepted, to the wealth of the rest of the world, and an income that in three years or less would equal the total wealth of any single European nation—indeed, our income alone probably exceeds the entire wealth of every nation in the world except five; a wealth equal to that of the whole British Empire and France combined. Can there be any question that with us as a nation, as with an individual under similar conditions, this wealth, if not properly used, is a national menace? Are we an exception to the history of nations, ancient or modern, where, as recently brought out by the great Italian historian Ferrero, the period of a nation's suddenly acquired wealth is the beginning of its deterioration and decay? The decline of the great Roman Empire began at a period when wealth poured in upon her from all sides. Professor Davis says of Rome at the beginning of the Empire:

> The Romans were suddenly put to the severest test a nation can meet—the trial of prosperity. The twentieth century opens with America enduring the same ordeal and it remains to be seen whether we shall bear it better than did Rome.

Is it possible that we are an exception to the often-quoted statement that the accumulation of wealth and the decay of men go together and to undermine that bold peasantry that is the backbone of a nation?

Every well-managed corporation and every well-run government lays out a budget planning in advance for its expenditures for the year ahead. How would a budget made of expenditures of the American people look? We are a great Christian nation, and yet we spend a little over two weeks' candy bill in our total contributions to missions! We are a generous and charitable nation, taking care of our dependent classes—sick and otherwise—as no other nation does. Yet the $140,000,000 we spend annually for charity of all kinds is a little over three-weeks' liquor bill! Indeed, if the report of Vice Commissions that New York, Chicago and Pittsburgh spend for commercialized vice $100,000,000 is correct, it is likely that the entire amount spent for charity of all kinds in the United States is a very much less figure than we spend for prostitution. It is not very much more than the amount we spend for one of our games—golf. Education has reached a higher position in America than in any other country; and yet the total amount we spend for education is less than we spend for jewelry; not much more than twice what we are spending for moving picture shows, and not as much as we spend for amusements! Out of an income of some $35,000,000,000, how do such national expenditures as the following appear, with regard to the comparative importance of different items:

Interest	$3,000,000,000
Liquor	2,300,000,000
Saved	2,000,000,000
Tobacco	1,200,000,000
Amusements	1,000,000,000
Automobiles	1,000,000,000
Sickness and medicines	1,000,000,000
Losses by credit	900,000,000
Jewelry	800,000,000
Crime	600,000,000
War and pensions	450,000,000
Candy and confectionery	365,000,000
Fire losses (mostly preventable)	250,000,000
Charity	140,000,000
Missions	16,000,000

Note what we spend for interest. The downfall of the government of Egypt came when she found that she could borrow money. The downfall of many a wealthy individual has been from misuse of credit, which, as John D. Rockefeller said, "Rightly used, is one of the best business assets, but, abused, has caused the downfall of individuals and nations."

With wealth and credit comes the borrowing habit that permeates our entire nation. Instead of meeting expenses from income, as the frugal, thrifty man should, Americans borrow. The government, state, county, city, township, individual—everybody borrows from the future to spend in the present. It is so much easier to spend future expectations than to wait until we can supply our wants from income or past savings. We are paying probably as much for interest in this country as the total savings of Great Britain and France.

Why is it that this country ranks fifteenth in percentage of savings accounts to population?

Switzerland	595 per 1,000
Norway	468 " "
Denmark	436 " "
Belgium	412 " "
Sweden	409 " "
Japan	400 " "
France	368 " "
New Zealand	360 " "
Germany	356 " "
Holland	340 " "
England	320 " "
Australia	300 " "
Tasmania	280 " "
Italy	232 " "
United States	109 " "

Why is it, with three times the income, we are saving but $2,000,000,000 yearly, no more than Great Britain, and only twice as much as France, with one sixth of our income; not even saving every year as much as we spend for liquor? Note the countries which head the list in number of savings bank accounts—Switzerland, Norway, Denmark, Sweden, Japan, Tasmania—countries not of great national wealth; yet the average savings bank deposits per depositor of Switzerland, Denmark and Norway exceed that of this country.

Why is it that a country of our wealth has nearly 1,000,000 dependent persons it is constantly caring for; that it has between 10,000,000 and 15,000,000 persons on the poverty line? Why is it that out of a hundred young men who start in life at age twenty-five, at the the age of seventy-five, of the sixty-three who die sixty have left no estate and that only three persons of the living are not dependent upon their children, relatives or charity; and that 95 per cent. of the remainder who die will not leave sufficient means to defray funeral expenses, unless insured?

Why is it, with the huge income of this country, 90 per cent. of its population finish their lives insolvent; and that even one tenth of the population in our great cities are buried at the expense of charity? Should we be satisfied with our social conditions in moderately asking that when every one comes into the world solvent, 90 per cent. should go out even more penniless than they came in?

It takes no character to spend money. It has been said that any fool can make money, but it takes a wise man to keep it. James J. Hill has said:

> If you want to know whether you are destined to be a success or not, you can easily find out. The test is simple and is infallible. *Are you able to save money? If not, drop out. You will lose. You may think not, but you will lose as sure as fate, for the seed of success is not in you.*

The late Booker T. Washington, a negro, shows his conception of thrift as character-building. It is, he said, "the ability to sacrifice to-day for to-morrow." And yet there are millions of persons in this country who do not even imitate the dog who buries his bone of to-day for to-morrow; the bee, the ant, or the squirrel, who lays by for the future. The most civilized nation in the world contains millions of persons who live as does the savage—merely from day to day. And further, there are millions—and those the ones who can least afford it—who do not even see the need of frugality and thrift; who make fun of a man like Rockefeller, because he is moderate and careful in his daily expenditures; who think it is creditable to be lavish in their expenditures beyond their means; $60 a month clerks, who regard it manly to order a meal and take the best seats at the theater for their girls, that both know are beyond their means.

It is the thrifty and frugal who are the backbone of the nation. It is they who supply its funds. It is they upon whom rests its credit. It is they who are not dependent upon society. It is they who support all its institutions, particularly its charitable ones. It is they who are not haunted by the grim specter of want throughout their lives. It is they who are forming habits of self-sacrifice and providence.

And further, it is they who, as a rule, are the happy persons. Micawber can hardly be taken as a type of happiness. Thrift is not miserliness; it is not niggardliness; it is not unhappiness; it is not avarice. These adjectives do not fit men like Carnegie and Rockefeller. It is the thrifty who have enjoyment because they can afford it, and enjoyment unhaunted by the fear of want to-morrow. It is the thrifty who are happier in the present because not fearful of the future—the saving, frugal, insured classes of the country. It is the thrifty who can afford to give their time to public matters, because not tied down to the actual needs of the day. And further, it is the thrifty who, by habits of self-sacrifice and foresight and frugality, are building the character that made the nation great when it was young, and that alone can keep the nation great. A man, or a nation, is worth what he saves, not what he spends.

Nor must we be deluded by the examples of the beneficence of the owners of great wealth. This also was characteristic of Rome in her wealthiest and also her decadent days. The days of Cæsar and the emperors immediately following were days of prodigality, of extravagant living and of lavish public gifts, but also of political corruption, of demagogism and of the decline and decay of the real people of Rome, who constituted its strength. It was then that millionaires controlled the Roman senate; that slaves could be bought for about fifty cents, while $40 a pound was paid for fish; and that banquets costing the equivalent of hundreds of thousands of dollars were common and when the wealthy bought public favor by munificent gifts with money easily acquired. What is the solution?

That Americans may realize the importance of frugality and thrift; realize that wealth, not rightly used, does not bring happiness, health or prosperity, personal or national; that we should more liberally patronize our great institutions for the systematic saving of money—the life insurance companies, the savings banks, the building and loan associations, our safe securities; that we should use money spent for less good purposes for the building of homes, so that it can not be said that 96 per cent. of the population of Manhattan Island are renters. We all should make budgets, even in one' s mind, in which the proportion of the probable income for the following year is laid out in some proper proportion; we must realize that it is not the money spent for necessities, but what we save—plus what is spent for education, for

charity, for wholesome recreation—that measures our advancement. The income altogether spent for food, clothing, housing and operating expenses leaves one at the end of the year just where one started. It is only by the amount saved and used for such self-improvement as may be gained from education, wholesome books and magazines, healthy recreation, travel, amusement, charity and, more particularly, laid by for the future in savings banks, in safe investments, in life insurance, that one can advance.

No business institution can be well run without keeping an account of expenses. Yet how many Americans keep no personal record of how their money during the year is spent! How can one find the weak spots in one's disbursements unless a record be kept? How easy to remember the money given one's wife or even given away and forget the money that is gone in cigars, in dinners, and perhaps in some ways that one is glad to forget! How helpful it is to voluntarily bind oneself to some definite method of saving, such as life insurance, probably the greatest institution for systematic thrift, where one makes one definite financial plan, extending far into the future, putting one under voluntary compulsion to lay aside so much money at a stated time each year; to put so much of one's weekly or monthly income regularly into a safe savings bank; the purchase of a home on the amortized mortgage plan, under which the mortgage will be made not for an indefinite time, but he reduced monthly; to buy good securities, by a definite plan of payment.

It is a wholesome sign that the thrift movement, starting in Europe with the war, has extended to this country; that there is a general realization of the necessity of frugality throughout the entire land; that the American Bankers Association, educators, journals, the Y. M. C. A., as well as, of course, the life insurance companies, are awakening to the opportunity and duty of arousing the richest nation in the world, with the greatest income, to so fortify herself that she may be secure not only against the foreign foe, but the most insidious and the most dangerous of all foes—herself. Only by the exercise and the continued exercise of qualities that make a people great, can greatness be maintained:

> No doubt but ye are the people—absolute, strong and wise;
> Whatever your heart has desired ye have not withheld from your
> eyes.
> On your own heads, in your own hands, the sin and the saving lies!

THE PROGRESS OF SCIENCE

MILITARY PREPAREDNESS

THERE is published in the present issue of the MONTHLY a series of papers on national defense and development presented before the Section of Social and Economic Science of the American Association for the Advancement of Science. It is not clear why one aspect of the subject was emphasized at the meeting, but it is doubtless desirable that the arguments for military preparedness should be represented in this journal, as well as the opposite point of view. An obvious difference exists between the eleven sections of the American Association devoted to the natural and exact sciences and the one devoted to the social and economic sciences. The former are in the main concerned with the discovery of truth, the latter in the main with the expression of opinion, and the same holds for the articles published in this journal. It would not indeed be desirable to include such diverse subjects in the same association and in the same journal, except for the fact that it is one of the most important of all objects to establish the scientific method in belief and in conduct.

It is, however, particularly difficult to make any progress in this direction at a time when the emotions are deeply stirred. The people of each of the European nations now at war believe sincerely that they are defending their country and their homes against cruel enemies that have long laid in wait wantonly to attack them. The responsibility for the war and the methods by which it is conducted are judged absolutely differently by Americans of English descent living in Boston and by Americans of German descent living in Milwaukee. It is believed by many that rivalry in armaments and in military and naval preparations intended for defense were the immediate cause of the present war and are likely to be the cause of future wars, yet nearly all the writers of the papers presented before the American Association and printed here argue that this country should increase its armaments and its military establishment in order to maintain peace.

The attempt of Germany to rival the British navy and the increased military preparations of Russia and of France may be regarded as at least among the causes leading to the present war. Nor is it evident that the efficiency for war of the different nations was proportional to their armaments. Their budgets in millions of dollars for the year just preceding the war were as follows:

	Army	Navy
Great Britain	224,300	224,140
France	191,432	119,571
Russia	317,800	122,500
Italy	82,928	51,000
Germany	183,090	111,300
Austria-Hungary	82,300	42,000

Austria-Hungary and Italy about balance, as do also Turkey and Bulgaria, on the one side, and Servia, Belgium and the partial participation of Japan and Portugal, on the other. The expenditure of Great Britain, France and Russia on their armies was about four times that of Germany, but this does not measure their relative efficiency at the outbreak of the war. The militaristic spirit of Germany is in part due to the armaments of the nations surrounding it. A nation may pay for armaments which not only make war more likely but which may help the enemy when war comes. The strength of Germany was its educa-

EUGENE WOLDEMAR HILGARD.

Professor of agriculture in the University of California from 1875 until his retirement as professor emeritus in 1904, who has died at the age of eighty-three years.

SIR CLEMENTS ROBERT MARKHAM,
Long president of the Royal Geographical Society, who has died in his eighty-sixth year.

tional, social and industrial organization; its disaster is its military preparedness, which gave power to the military caste and led them to make war when and as they thought it could be waged victoriously. The strength of Great Britain on the seas is in its commerce, of which dreadnaughts are merely a dangerous symbol. The strength of a nation, even when at war, is not in armaments that can be purchased, but in its people and their institutions.

SCIENCE AND NATIONAL STRENGTH

It might have been supposed that a discussion on national defense and development before the American Association for the Advancement of Science would have been concerned chiefly with emphasizing the importance of scientific education, scientific research and scientific organization as leading factors in the maintenance of peace and of national efficiency in case of war. If the battle of Waterloo was won on the playgrounds of the English public schools, it may be that other battles have been lost in the colleges of Oxford. At all events the complaint is made in England that its relative lack of success is due to its neglect of science. The classically trained dilettante, the political doctrinaire, the lawyer politician, the military martinet, are not fit leaders of a nation. The strength of this nation is in its engineers and physicians, in its scientific men, few though they are, in the great mass of the people engaged in productive agriculture and industry. We have shown what we can do in our railways, our automobiles, our telephones, what we can not do in our municipal and state governments, an admixture of success and failure in our schools and in our industrial organization.

A billion dollars spent, as is proposed, on the army and navy, as now organized, would be an incitement to war and would only be of moderate use in a strictly defensive war. The armaments would soon become obsolete and other billions would be called for. A billion dollars spent on scientific education, on scientific research, on public health, or on public works, would be money invested in the way yielding the largest returns, and would accomplish more than armaments to make the nation strong in defense.

As the writer of this note urged before the war, we should have the best army for defense and improved police forces if all local police were soldiers, one twelfth of their wages being paid by the nation and one month annually being spent in camps and drills. Idling in barracks is a method for the promotion of war, drunkenness and disease. The engineering corps, the health service and the commissariat are the most important factors in modern warfare. Engineers, health officers, inspectors of food and others employed by the nation, the states and the municipalities should be at the same time officers in the army and those under them enlisted men. A well-organized and efficient army for defense would thus be maintained at comparatively small expense and be an institution for education instead of for demoralization.

The navy should be converted into a merchant marine, carrying a postal, express, freight and passenger service to every port in the world. At the cost of an idle navy five to ten times as many ships and men could be maintained and employed in useful work. In case of war swift ships and experienced men would win over dreadnaughts. Shipyards and factories for armaments and ammunition should be owned by the nation and manned by officers and enlisted men. The army and the navy can be made self-supporting nearly as easily as the postoffice.

If we had for the past three years employed a large force of men on the Mexican border to build railways and roads, irrigation dams and other public

works, it would probably have been a good investment. The net cost would certainly have been less than maintaining there an idle army, and our neighbors would have learned from us the ways of industry and peace instead of being irritated by an apparent threat. There would probably have been no raid; if it had been necessary for us to punish raiders it could have been done more effectively and with less friction than by the army as at present organized.

It might well be wished that instead of listening to Mr. Wise Wood and other frightened gentlemen, it were possible for the American Association for the Advancement of Science to use its influence to teach the president, the congress and the people that education, scientific research and the applications of science in agriculture and in industry, in the promotion of health and the prevention of waste and vice, are the ways to develop the greatness of a nation, to make it potent in maintaining peace, unconquerable in a war of defense.

SCIENTIFIC ITEMS

We record with regret the death of Ivan Pavlov, the eminent Russian physiologist; of Sir William Turner, principal of Edinburgh University, distinguished as an anatomist, and of Dr. J. Wilhelm Richard Dedekind, the German mathematician.

The Hébert Prize of the Paris Academy of Sciences has been awarded to Professor M. I. Pupin, of Columbia University, for his theoretical and experimental researches in electricity.—The William H. Nichols medal has been presented to Dr. Claud S. Hudson by the New York section of the American Chemical Society.—The Albert medal of the Royal Society of Arts has been presented to Sir J. J. Thomson, "for his researches in chemistry and physics and their application to the advancement of arts, manufactures and commerce."

The forty-fifth anniversary of its establishment was celebrated on February 9 by the United States Bureau of Fisheries, with the unveiling of a tablet in memory of its founder, Spencer Fullerton Baird, presented by his associates and followers. The bronze tablet bears a basrelief of Professor Baird with the inscription: He devoted his life to the public service and through the application of science to fish culture and the fisheries gave his country world-wide distinction.

THE SCIENTIFIC MONTHLY

MAY, 1916

THE EVOLUTION OF THE EARTH[1]

I. Earth-Genesis

By Professor THOMAS CHROWDER CHAMBERLIN
THE UNIVERSITY OF CHICAGO

THE evolution of the earth is but the domestic chapter of the evolution of the heavens. In the great volume that records the history of the stellar galaxy no doubt there are a multitude of little chapters of planetary evolution. It is our task merely to tell the story of our own planet. The evolution of other planetary systems may not always have followed the same lines. No doubt many agencies are concerned in the evolution of the bodies that attend the stars. Quite different methods may have given rise to these attendants. It is our task to detail, if we may, the particular way in which our planet and its kindred planets came into being.

The qualities inherited by the earth from the mode of its birth very likely carried into all its subsequent history influences of high potency. Unless we detect the essential nature of these at the start, we will quite surely go astray in the interpretation of the events that followed. It is scarcely less than imperative that we dwell with some care on the initial stages.

Our method must be that of the naturalist—the geo-naturalist, the cosmo-naturalist; it must be an endeavor to find in the features of the earth and of the planetary system the autobiographic story of the planet's experiences recorded automatically in planetary language.

There was a time when mankind very generally was wont to treat with levity the endeavors of geologic pioneers to read the ancient history of the earth from its automatic record. But those days have passed: the intelligent world to-day accepts with confidence the story of the earth's history as it is read in strata, in life relics, in water-marks, in the necks of ancient volcanoes, and in the stumps of vanished mountains. The world recognizes and respects the lithographic story that

[1] Third series of lectures on the William Ellery Hale foundation, National Academy of Sciences, delivered at the meeting of the academy at Washington, on April 19–21, 1915.

tells—with incompleteness, to be sure, but with great fidelity—the history of the earth reaching back for perhaps a hundred million years.

Back of that, even the scientific world is still wont to regard the story of our planet as falling into obscurity, for the lithographic scriptures cease to be fully legible with the Paleozoic terranes, and with the lowest Archean, the whole lithographic record becomes inaccessible. We are wont to assume that because this lithographic record has failed us, there is no other record to which we may have recourse. But there are dynamic vestiges of creation as well as lithographic vestiges, and some of these dynamic vestiges bear witness to the much earlier stages of terrestrial history, reaching back even to the earth's nativity. We may say with confidence that these dynamic vestiges tell the story of its birth; we may not say with equal confidence that we have read the story aright, or that it can as yet be read aright; we may merely say with confidence that the story is thus recorded. The reading of dynamic records presents inherent difficulties; we are but scantily familiar with such literature; but the record is none the less sure; certain dynamic records are even more instructive than lithographic inscriptions.

Our planetary system records itself as a group of bodies circling about their controlling star, the sun, in ways that are full of meaning. There are singular relationships one to another; there are remarkable symmetries and departures from symmetries; these relationships tell the story of the kinship of the planets to one another, and their kinship to the sun. In some large measure—whether we can yet read it aright or not—they tell the story of the planetary births. They even tell vital facts of planetary history. The harmony in the planetary family is such as to make it quite sure that throughout its whole history it has never been seriously perturbed by external influences. Such are the peculiarities and the symmetries of the planetary organization that it is fairly safe to say that during its existence, be it a hundred million years—or ten hundred million years, if you please—the system has never been so near to another body of stellar massiveness as to suffer serious disturbance of its internal relationships. If the solar system had ever been within a billion miles of another body of the mass of our sun, the record of that approach would appear in the dynamic vestiges of the system as it is seen to-day.

In this record of internal harmony, this record of an undisturbed career, there lies a guiding suggestiveness that may not appear on first statement. The center of the system is moving through space at the present time at about nineteen kilometers per second; around this center, as it speeds through space the members of the planetary family circle in close attendance on their governing star. As a harmonious group they have thus swept a broad path throughout all the history of the system. The immensity of this sweep at once challenges the power of the imagi-

nation to picture such a vastness of space and such an openness of distribution of stars within it as to make possible an undisturbed journey of so broad a system.

So wide deployment of the stellar system implies energies and movements of a stupendous type. These constituted the dynamic environment of the earth's nativity. The nature of these stupendous energies and the laws of these vast activities may serve as our guide in a search for the conditions of planetary birth.

We may at once catch a hint of no little value. The massive center of the solar system is moving among the stars at the notable rate of nineteen kilometers per second; the earth is circling about it at the higher rate of thirty kilometers per second and yet is attending it in its journey through space. The earth pursues a spiral path of notably greater length than the path of the sun. We ourselves on its surface sweep around the earth with its rotation and describe a more tortuous, a longer and a swifter path than the center of the earth itself. The molecules of the atmosphere fly to and fro with prodigious rapidity while they accompany us in our tortuous course; in their still more devious paths they are moving much faster than we. If you will recall the initial lecture of this series by Sir Ernest Rutherford, it will bring to mind particles whose velocities are prodigious, even when compared with the swiftest of the swift celestial movements. Out of this comparative series we may catch a glimpse of the law that the smaller bodies of celestial space move more swiftly than the larger bodies, as a general rule; a law inherent in the nature of the case, a law founded on the natural workings of the principle of the partition of energy.

The suggestions of this law are adverse to those inherited ideas which associate inertness with scattered matter; which assign it the lazy habit of "floating in space," which assume that it may slowly assemble. These seem to be inheritances from the picture of primeval chaos. Quite the contrary, it would seem that the little bodies and the scattered matter are the most active of the active in the celestial world. No vestige of chaotic inertness seems to be found either in observation or in good theory.

The vast deployment of the stars implied by the long swift journey of our system among them teaches us at the same time of the immensity of the celestial energy that actuates the vast moving assemblage. We are accustomed to look to the stars themselves as the great sources of energy —and their radiant output is indeed prodigious—but the motion of the stars themselves is an expression of greater energy than is their radiance, while the deployment of the stars involves potential energies which are a high multiple of both these other great sources combined. And then there are the unmeasured resources of radioactivity.

These general observations are but a means of catching some glimpse

of the environment which encompassed the nativity of the earth and contributed to its endowment. These prodigious sources of energy, the radiant activities, the inertia of stellar movement, the potential energies of deployment, and the occult energies of atomic dissociation combined to endow the earth with those energies that have actuated it during its prolonged history. In the vast openness of heaven, amid its intense activities, and partaking of its prodigious energies, the earth appears to have had its birth.

There are two contrasted types of hypotheses of the origin of the earth and of its kindred planets. The one class have taken for their start the assumption that the parent matter was already widely dispersed in space. They have contented themselves with simply endeavoring to interpret the segregation that followed. They have been content with one half the story. The other class have felt the obligation first to find adequate agencies by which the requisite matter might have been deployed, and then, from that deployment, and in full consistency with it, have endeavored to interpret the mode of its reaggregation into a new system. These hypotheses endeavor to recognize the forerunning destructive factor as well as the sequent constructive factor. They thus try to decipher the whole story; starting from a beginning in conditions such as exist in the heavens to-day, they try to trace the evolution on to an end like that presented by the earth and its kindred as we now find them.

To the first type belongs the most ancient genetic concept that has come down to us, an evolution from primeval chaos. If I have been so fortunate as to impress what seem to me the most essential conditions that dominated the celestial environment at the time of the earth's birth, there will be little need to dwell upon any idea inherited from the ancestral picture of primeval chaos. The ancient idea of chaotic inertness, of mere passive susceptibility of segregation, awaiting endowment with exotic force, seems to have no warrant in anything now observable in the stellar universe. If the picture of primeval chaos were ever true, it would seem that its day must have lain far back of the birthday of the earth.

The hypotheses that have commanded the largest assent during the past century have usually started with assumptions somewhat akin to the ancient concept of chaos, but yet distinctly removed from it by postulating conditions and endowments akin to those supposed to reside in the dispersed states of matter now seen in the heavens. The task that these hypotheses set themselves was the delineation of the course of transformation from a postulated nebulous state into an organized planetary state, a process at once of nebulous partition and of nebulous concentration. The segregative work was assigned chiefly to gravitation; the partitive work, the separation of matter to form the individual

planets, was chiefly assigned to centrifugal action. In the brevity enforced by the limits of the hour, it will be convenient to group all such hypotheses into a centrifugal genus. The essential feature of this genus lay in the assigned tendency of the nebulous matter to concentrate itself until its velocity of rotation set off certain parts which later condensed into planets, planetoids and satellites. To be consistent, every hypothesis belonging to this genus, whatever its special terms, must stand the test of a fair accord with the criteria that inevitably attend the results of centrifugal action. The parts set off by such action should lie somewhat accurately in the plane of the equator of the body that set them off, the sun. The sun itself must retain a rotatory velocity in keeping with its assumed competency to shed matter in this way. How does the centrifugal hypothesis stand these critical tests? The earth is now revolving around the sun at thirty kilometers per second. If it were set off by centrifugal action at this distance from the center of the system, the rim of the rotating mass should have then moved at this notable velocity of eighteen miles per second. When the parent mass shrank to the orbit of the innermost planet, Mercury, it should have had an equatorial velocity of nearly fifty kilometers per second. The rotation should have further increased with further contraction. If the rotation of the sun were competent to cast off masses from its equator with its present dimensions, it should have a velocity of 435 kilometers per second. As a matter of fact, it has a velocity of about two kilometers per second. Here is a grave discrepancy. The sun's equatorial velocity is scarcely a two-hundredth part of what is required to discharge matter centrifugally from its present surface.

The equatorial plane of the sun is inclined to the orbit of the earth; by the hypothesis, the matter of the earth should have been shed quite accurately in the sun's equatorial plane. This plane is also inclined to the orbital planes of each one of the planets. More significant still, it is inclined to the invariable plane of the planetary system which represents the dynamic summation of the planes of all the planets. The inclinations, to be sure, are not great, the earth's orbital plane being inclined 7° 15′ to the equatorial plane of the sun; but when the prodigious inertia of the planetary movements is taken into account, even this variation is a notable discrepancy; perhaps it is not a fatal discrepancy in itself, but it adds to the gravity of the great rotational discrepancy. If, as one of the incidents of the generation of the new planetary system, the sun's rotation was reversed, as seems not improbable from the remarkable slowness of the sun's present rotation and the inclination of its axis, its original inclination would be as large as an exacting application of the law of probabilities would demand.

The rotational discrepancies are not confined to the simple facts of slowness and inclination. If the rotational value of the sun were in-

creased by the accession of all the planetary bodies carrying into it all their momentum values, with the consequent acceleration of its velocity, it would still be incompetent to discharge from its surface centrifugally the several planets in their places. The elaborate investigations of Dr. Moulton have placed this upon a specific and invulnerable basis. The discrepancies disclosed at the several stages of the postulated evolution range from disparities of 140 : 1 up to 1,800 : 1.

So also, there are discrepancies between the masses of the several planets and the momenta they should carry under a systematic process of centrifugal separation. If the postulated nebula at the time it was, by hypothesis, preparing to shed the great planet Jupiter, be restored, every layman more or less familiar with mechanical laws may estimate for himself, in some rough way, at least, the relative value of the rotatory momentum carried by the whole body and by an equatorial rim of one-thousandth part of the body, respectively, making all due allowance for the fact that the momentum of the outer part has a higher value than that of any similar part within, not only because it moves faster, but also because it moves on a longer arm. The mass of Jupiter and his moons taken together is somewhat less than a thousandth part of the mass of the postulated nebula at the time the separation of the supposed Jovian ring took place. Now if one has formed such a rough estimate one will be ready to appreciate the meaning of the fact that Jupiter actually carries more than 96 per cent. of the total value of the rotatory momentum of the nebula at the time of its assigned partition, while the 999 parts left behind by hypothesis carry only the remaining four per cent. The sun itself, massive as it is, now carries only about two per cent. of the momentum values of the whole planetary system, while 98 per cent. is carried in the attendant bodies, and yet the total mass of these attendant bodies is only about 1/745 of the solar mass. That such are not the proportions that would arise from a systematic separation of the planets from a parent nebula by centrifugal action is quite clear even on simple inspection: it may be confirmed by computation, which shows that there are even more remarkable discrepancies in the cases of some other planets.

A very slight portion of these discrepancies may be referred to tidal action, but the computations of Sir George Darwin show that this amelioration is extremely trivial.

There are other striking discrepancies. If the centrifugal mode of planetary separation obtained in the solar system, the planets should take less time to rotate upon their axes than the satellites to swing around them at some distance, and yet Phobos, the little inner satellite of Mars, sweeps around the planet about three times while the planet rolls around once. Moulton has pointed out, also, that the little bodies that make up the inner side of the inner ring of Saturn circle around

that planet about twice while the planet rotates once. If tidal friction is appealed to as a means of bringing these into consistency, it is found available, as Dr. Moulton has shown, only if one of these cases is three thousand times as old as the other.

It is a necessary inference that satellites, shed centrifugally, should rotate in the same direction as the planet from which they were cast off; and yet it has recently been discovered that one of the satellites of Saturn rotates in a direction contrary to the planet and its eight other satellites. Still more recently it has been discovered that two of the satellites of Jupiter disregard the family habit in a similar fashion. This behavior seems fatally inconsistent with a centrifugal origin.

If we turn to the heavens for their testimony, none of the many thousands of nebulæ show a concentric system of symmetrical circular rings, fulfilling the postulates of the hypothesis. Figs. 1, 2, 3 and 4 are introduced to show such imperfect degrees of approach to conformity with this hypothesis as are presented.

The foregoing formidable series of grave discrepancies, conjoined with this lack of convincing illustrations of centrifugal evolution in progress among the many thousands of nebulæ now known, seem to require us to set aside the whole centrifugal genus of genetic hypotheses, including as its foremost exponent the venerable hypothesis of Laplace—so far, at least, as the genesis of our planetary system is concerned. We may not do this without a recognition of the profound stimulus that these hypotheses have given to inquiry into the origin of the solar system during the past century.

The hypotheses that have commonly been called meteoritic have usually been built up on a structural or textural basis rather than a dynamic one. They have been rather theories of the constitution of nebulæ than theories of the origin of the earth. They have not been worked out into the specific details of separation and followed out through all concentrative processes down to the stages of the existing planets. They do not, therefore, lend themselves readily to brief discussion. As theories of the constitution of nebulæ they have not been sustained by progressive inquiry.

In so far as supposed meteoritic assemblages constitute swarms and are actuated by collision and rebound in quasi-gaseous fashion, as developed by Sir George Darwin, they are subject to the grave difficulties we have just cited against the more familiar gaseous forms of the centrifugal genus.

In so far as the postulated meteorites are supposed to pursue individual orbits, a series of difficulties of a different type are encountered. The precise form of these difficulties varies according to the specific form given the hypothesis. If the planes of revolution of the individual meteorites lie in various directions, as is natural in a heterogeneous

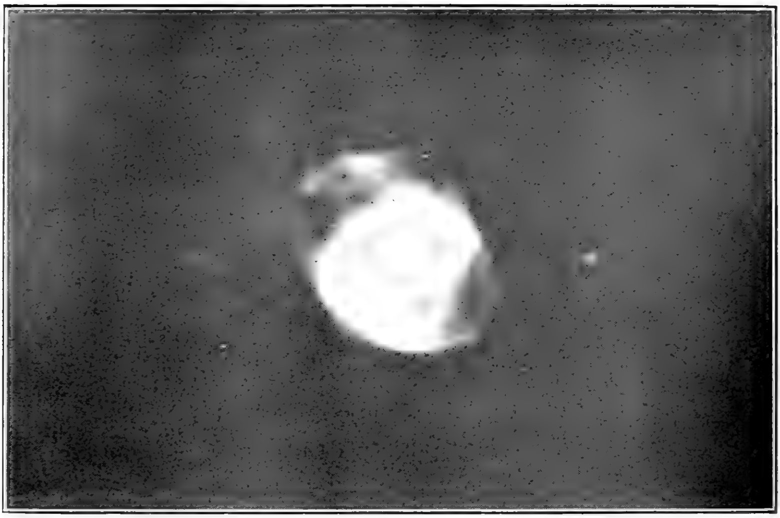


FIG. 1. NEBULA N. G. C. 6543, DRACO, PLANETARY. Spectrum, bright lines on a continuous background. Photo from Mt. Wilson Solar Observatory. Note apparent absence of gradation and hydrostatic support.

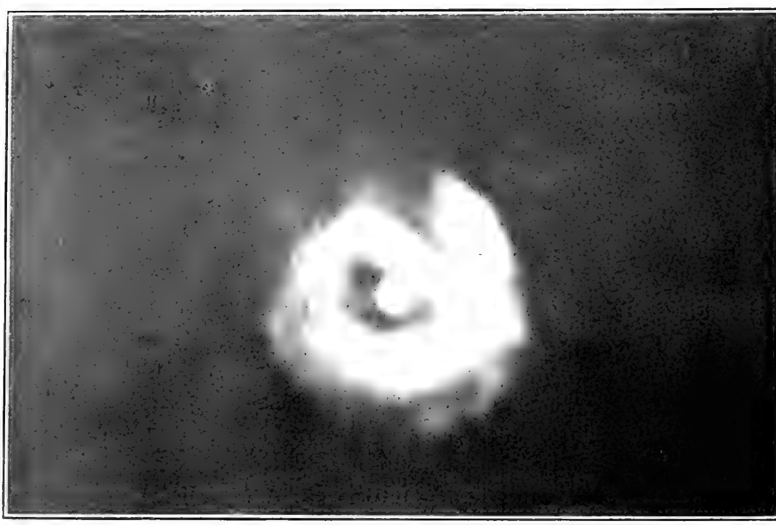


FIG. 2. NEBULA N. G. C. 7662 (H IV 18). The Andromeda planetary. Photo from Mt. Wilson Solar Observatory.

assemblage, the concentration tends toward globularity, whereas our planetary system is pronouncedly discoidal. The difficulties of asssigning a globular cluster of revolving meteorites such a system of dynamics as shall cause them to evolve naturally into a highly discoidal system of revolutions, with 98 per cent. of the moment of momentum concentrated

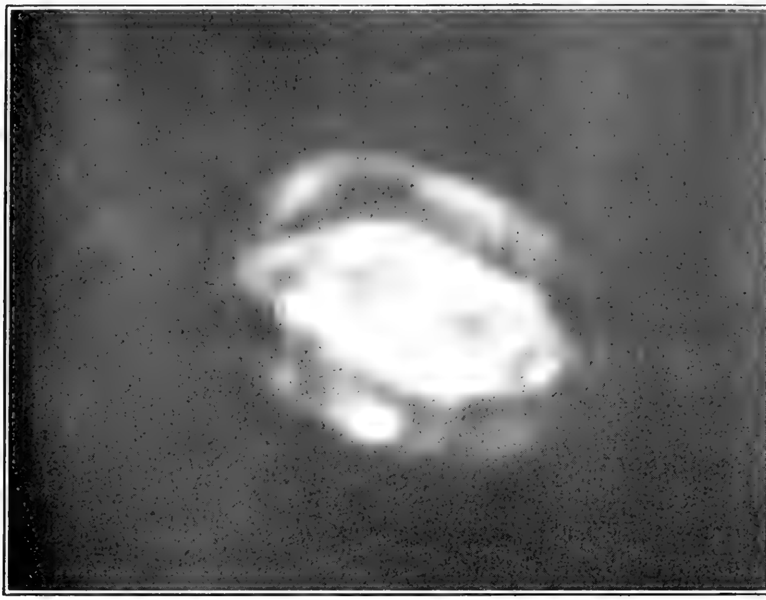


FIG. 3. NEBULA N. G. C. 7009. "Saturnian" planetary. Note the faint "ansæ" in the extrusion of the major axis. Photo from Mt. Wilson Solar Observatory.

FIG. 4. NEBULA N. G. C. 7217 (H II 207). Note the knotted structure and the faint oblique spiraloid tracts. Photo from Mt. Wilson Solar Observatory.

in 1/745 of the outlying material, are very grave. The difficulties of aggregating sparsely scattered revolutionary meteorites, highly endowed

with momentum, into a few large planets, without special collecting centers, are also grave.

There is an inherent difficulty in assigning any competent aggregative tendency to meteorites as such, if we may judge from the dynamics of those within reach of observation. With their observed velocities their momentum is extremely high relative to their attractive power. The individual attractive power of an average meteorite is almost immeasurably feeble. The sum total of attraction of a great swarm of meteorites, if such exist, might indeed be high, but it is an attraction toward the common center, not toward outlying points where the planets must grow up. In and of themselves, meteorites are controlled by a dispersive rather than a concentrative tendency. It is only by starting with the *assumption* of an enormous assemblage whose initial gravity is sufficient to hold the individual meteorites under control, that it is possible to proceed rationally at all, and then the concentration is presumably toward the common center of gravity and not toward outlying planetary centers.

If the difficulties of a definite segregation into a few large planets revolving in a sharply appressed disk have been met at all under the meteoric hypothesis, it has been rather by a tacit assumption of the appropriate concentrations than by the assignment of specific reasons for such an aggregation. But concentration must already have gone far before it comes to have much aggregating force. Even the full-grown earth has relatively little power to swerve the meteorites from their paths. It collects them, to a trivial extent, chiefly because it lies in their path, not because it is a controlling center for their aggregation; their velocities are too great for effective concentration. The earth can not control a velocity so great as seven miles per second, while the average velocity of meteorites relative to the earth seems to be three or four times that. In the absence of effective collecting centers the mutual collisions of meteorites moving at observed rates would result in fragmentation and still more minute dispersion. This is, with little doubt, the reason why most meteorites are so small, and why their habits are so pronouncedly dispersive. They are food for the scant feeding of massive bodies already formed, but they are deficient in formative power themselves.

The foregoing are at best but half-hypotheses. They start with assumptions of certain kinds of nebulæ already formed and merely try to trace the evolution of these into a planetary system. The more complete classes of genetic hypotheses endeavor to go back to the beginning of the dispersion that prepared the way for reaggregation into a new system. They thus try to tell the whole story. This broader endeavor early found a representative in a theory quite as venerable as the hypotheses of Kant or Laplace, but unfortunately it is not worthy of serious consideration as a specific explanation of the origin of our planetary system. It is

merely representative. More than a century ago the naturalist Buffon suggested that a comet might have collided with the edge of the sun and have driven off sufficient matter to form the planets. While this is obviously an untenable view, the dynamic concept of a glancing collision of one form or another between two bodies has been the basis of a series of hypotheses which may be grouped together as a collisional genus. This genus avoids some of the fundamental difficulties that lie so gravely against the preceding hypotheses. A collisional impact might leave the rotation of the sun as slow as it actually is. The collisional effect might obviously be accelerative or retardative according to the mode of stroke. By hypothesis the sun might have any possible velocity of rotation. The sun's axis might lie in any direction. So also, the matter driven from the edge of the sun might, by hypothesis, have all the momentum that any of the members of the planetary system possesses in perfect consistency with the sun's slow rotation and its oblique axis. It is no small merit in this genus of hypotheses to escape the fundamental difficulties of rotation and momentum that have proved to be so grave in the centrifugal genus.

But the collisional genus encounters, in its turn, certain formidable difficulties. In the first place, the mass of the sun, just before the collision, could not well have been less than it is now, and hence an approximate velocity may be assigned the collision. A body coming from without the sun's sphere of control would, neglecting any pre-existent velocity of its own, strike the edge of the sun at a velocity of the order of 600 kilometers per second, due to the sun's powerful attraction. If the body fell merely from some outer part of the sun's sphere of control, it still would have a velocity of a very high order of magnitude. If the sun's volume were larger at the time and the stroke took place farther from the sun's center of gravity, the velocity would indeed be lower; but still it would be high under any reasonable hypothesis of this type. To follow logically the consequences of such a glancing collision, it is necessary to give due weight to the violence of the encounter which these high velocities imply. The normal effect of such collisions would be a radial dispersion of both the striking and struck matter diverging from the point of encounter in various forward directions, except perhaps in such as were protected by the undispersed portions of the sun and of the colliding body; in other words, there should be a more or less fan-like radiation, with perhaps a truncated side representing the protecting effects. The two great nebulæ of Orion (Fig. 5) seem, in some measure, at least, to fulfil these specifications. Normally the dispersion, under conditions so violent, would be extremely high. Nuclei for gathering together the dispersed matter into a few great planets would seem to be counterindicated by this, and the conditions for aggregation in any planetary form would apparently have been unpropitious.

FIG. 5. THE GREAT NEBULA OF ORION AND ITS COMPANION NEBULA. Bright line spectrum. Note evidences of special structure, absence of graded continuity and of hydrostatic support, in both nebulæ. Photo from Yerkes Observatory.

But there is a more radical difficulty. Under the laws of mechanics, the dispersed matter driven off by the collision, if it were kept under control by the sun at all, must return to the point of collision and there be subject to a second collision, with a similar necessity of return and so on. Even if by some perturbation in the course of their outward or returning path, some of the dispersed matter were driven into new paths so that they escaped recollision, they must probably have assumed very eccentric and diverse orbits. The orbits of the planets do not present the characteristics that seem derivable from such sources. The orbits of all the planetary bodies are sub-circular, and they are distributed about

one another with a certain measure of symmetry that does not seem to be a normal product of such a marked asymmetry as would necessarily arise under the collisional hypothesis.

Thus this genus of hypotheses—whatever specific forms may be given the individual hypotheses under it—seems to have but a scant basis of acceptability. Without much question collisions occur in the heavens and evolutions must arise from the products of such encounters, and so the theory has its place in a general study of the evolution of the heavens. But grave difficulties lie in the way of supposing that a solar collision gave birth to our planetary system.

These four types of hypotheses, the chaotic, the centrifugal, the meteoritic, and the collisional, embrace essentially all that commanded much attention during the past century. Of these it is perhaps safe to say that the centrifugal genus, especially as represented by the Laplacian hypothesis, commanded more adherence than all the others combined.

There remains, however, another possibility, less obtrusive in its nature than any of these. For this reason perhaps it was more tardy in receiving consideration. It centers on *dynamic encounter,* that is, the dynamic effect which arises from the close approach of massive bodies without bodily collision. Its effects have certain of the qualities that arise from bodily collision but they are free from certain other qualities that give rise to grave difficulties in their application to our planetary system. While thus related to collision, dynamic encounter is radically distinguished from it. The approach is close only in an astronomical sense. It may range from the mere escape from collision up to a few millions, a few hundred millions, or a few billions of kilometers. The encounter is purely a dynamic one; it is an interpenetration of spheres of gravitative influence involving a contest for gravitative control.

If a star were alone in space it would be surrounded by an illimitable sphere of gravitative influence, strong near the star but declining rapidly as distance increased, yet never entirely disappearing, theoretically at least, within the bounds of space. If a second star were introduced at any point in space, the new gravitative influence would interpenetrate the previous sphere of influence; there would be both conflict and coordination of influence; the two stars would divide the previous sphere of control of the single star, each having its own sphere of dominance. If a multitude of stars occupy space—the actual case—their gravitative influences interpenetrate in a most intricate way, and yet about each star there remains a space within which its gravitative influence is greater than that of its rivals. Each star has its sphere of control; as does also each planet, planetoid and satellite.

Now it is to this conflict and coordination of stellar attractions that the genesis of the dominant class of nebulæ, the spiral, is assigned. It

is to the evolution of a spiral nebula that the genesis of our planetary system is assigned.

Many years ago Roche showed by mathematical analysis that if a satellite be made to approach its primary on an in-running spiral, it will not retain its integrity until it reaches the surface of the primary but will be torn into fragments at a point 2.44 times the radius of the primary, provided the two bodies are homogeneous in density and all internal forces except gravity are neglected. If the density increases toward the center, the limit is larger. The Roche limit for the earth is about 18,000 kilometers; if the moon were to circle down toward the earth, it would be torn into fragments at about 11,000 miles from the earth's center. In being thus disrupted it would probably take on a form analogous to the fragmental clusters that are thought to form the heads of comets. The Roche principle with proper modifications is applicable to any celestial body approaching another on a curved path. If such approaching body has been greatly compressed previously by its own gravity, its internal elastic stress may greatly exceed its cohesion. In gaseous bodies, indeed, cohesion may be said not only to be absent, but to be replaced by repellancy which is only kept under control by the bodies' gravity. If the approaching bodies are great globes of gas, such as are the stars, and if they are subject also to powerful eruptive action, as is our sun, extraordinary effects may arise when a close swift approach is made on a more or less sharp curve, as such approaches always are.

Now imagine a star passing close to another star or massive body, pursuing necessarily a rather sharp curve at its point of closest approach and moving inevitably at very high speed; picture the enormous concentration of energy within such star arising from its molecular activity under its high gravitative compression; add to the picture the inherent eruptive tendencies that arise from this, if it belongs to the type of our sun, and it will furnish the working conditions of the case. Now imagine the interpenetration of the gravitative influences as the two bodies approach one another. Particularly note the way in which the gravity of the massive body penetrates, modifies and even neutralizes the gravitative control of the lesser body over its own substance, the force that had concentrated it into a globular form and strongly compressed it, and the picture will give the working elements for a concept of the prodigious eruptive and dispersive effects that will attend so simple an incident as a close approach. It is easiest to follow a case in which one body is much more massive than the other and is assumed to be so solid and non-explosive as to be little affected, so that the main response is limited to the minor explosive body. The action will be of the tidal type and follow tidal principles; indeed, it will be an extraordinary modification of a tidal process. Under such tidal action the star first becomes

elongated toward the passing body. The eruptions are then concentrated in the tidal cones. The ejections are shot toward and from the controlling body. The dispersive action constantly lies in the line of readjusted attractions between the centers of the two bodies. This line is constantly shifting its position; at the critical stage it is shifting rapidly; but this shift must always be in the plane of movement of the controlling body. It may be helpful to picture the elongated erupting star as a Janus-faced ordnance firing gaseous bolts fore and aft as it swings swiftly about its massive neighbor. The chains of missiles thus shot in opposite directions during the whirl naturally take on the form of two spiral curves as illustrated in Fig. 6. The two-armed feature of the

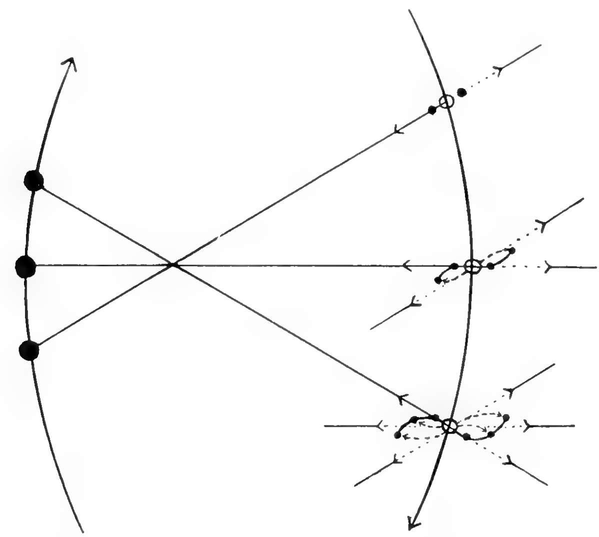
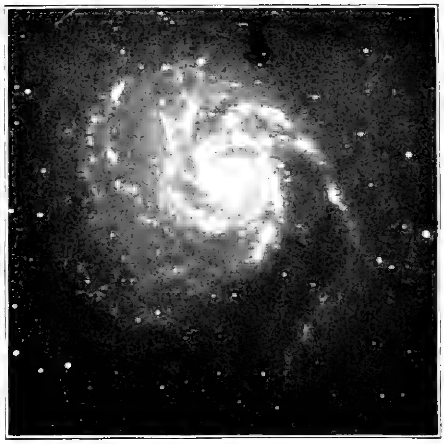


FIG. 6. DIAGRAM ILLUSTRATING A HYPOTHETICAL MODE OF FORMATION OF A SPIRAL NEBULA.

spiral which results is amply exemplified in the spiral nebulæ. A star with an inherent explosive habit passing near a massive body thus, by interpretation, is converted into a spiral nebula.

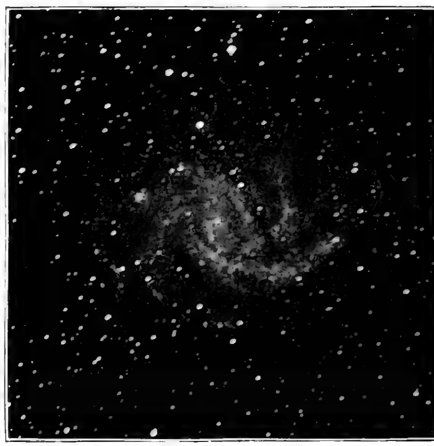
How large a portion of a given star will be shot forth into spiral arms depends on the closeness of approach, the elastic compression of the star, the massiveness of the passing body, and other factors. If the star passes within the Roche limit of the more massive body it may, theoretically at least, be entirely deployed into spiral arms, leaving little or no nucleus behind. If the approach be less near, the residual nucleus will be correspondingly larger. A series may thus be formed which grades from the most dispersed forms in which spiral arms preponderate with almost no nucleus, up through spirals with greater and greater

1. M 51 Can. Ven. — N. G. C. 3572-3574.

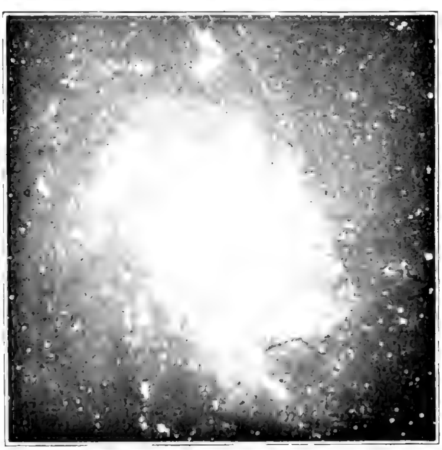


2. M 101 Urs. Maj. — N. G. C. 3770-3771.

3. M 74 Piscium — N. G. C. 372.



4. H IV 76 Cephei — N. G. C. 4594.



5. H 33 Trianguli — N. G. C. 352.

6. H I 53 Pegasi and her nebula.

PLATE I. SPIRAL NEBULÆ.

nuclei and less and less dispersed matter, ending in those in which only a minute fraction of star substance was drawn out into spiral arms. As already noted, these arms or clusters of arms start at opposite sides of the nucleus and swing out in opposite directions with curvatures in the same sense. This singular feature is seen to be very persistent in the many thousands of spiral nebulæ in the heavens and may well be regarded as highly significant of the process that gave rise to them.

It is worth while to note that though the degree of dispersion of a star into a spiral nebula may reach even to the essential deployment of the whole star, in certain cases, it is not violently catastrophic in any such degree as follows actual collision. It is partitive rather than extremely dispersive and dissociative. The disruption takes place by a

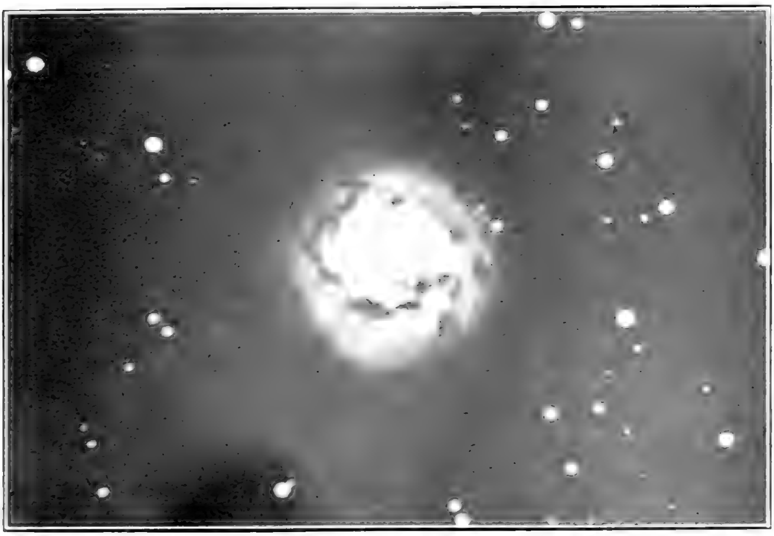


FIG. 7.—A SPIRAL NEBULA WITH NEARLY CIRCULAR OUTLINE AND RELATIVELY FEW LARGE KNOTS. N. G. C. 278. Photo from Mt. Wilson Solar Observatory.

series of gas-bolts shot out in succession. The larger of these gas-bolts are supposed to retain mass enough, and hence self-gravity enough, to hold themselves together and so to constitute the nuclei to which the more scattered matter gathers to form the planets, planetoids and satellites into which the nebula later evolves. These bolts shot out by the successive pulsations of the eruptive action form into the knots that so distinctively characterize the spiral nebulæ.

With extreme cases of approach within the Roche limit, and with very close approaches generally which give rise to highly deployed nebulæ, we have nothing to do, except by way of illustration, in our search for the genesis of our planetary family. To fit this case, our sun is sup-

posed to have shot forth bolts to the amount of only 1/745 of its mass to form the members of the planetary family. No doubt some additional matter was involved, but even when large allowance is made for such matter as may have been projected outward and yet returned to the sun, and for such other matter as was possibly shot so far out as to be drawn away by the passing star, and for some that may have been thrown beyond the control of either body, the fraction of the solar mass required to meet the demands of the case still remains very small. There is no reason to suppose that the sun's career as a star was radically affected. The approach was probably a rather distant one, in this particular case.

When the multitude of the heavenly host is considered, and the various directions and speeds of their motions are noted, the event to which the origin of the parent nebula of our planetary system is assigned must be regarded as one of the simplest and most inevitable that could well be named. There is little ground for doubt that actual collisions occasionally occur. There are six or eight chances that a star will pass through even the Roche limit of another star to one that it will collide with it. The chances that a star or massive dark body will pass near enough to an eruptive star to give rise to effective projections from its tidal cones, rise to very much higher order. Here again, the tenor of observed facts tallies with the nature of the theory offered, for the spiral nebulæ are many times more numerous than any other class.

Let us follow a little more closely the assigned method of evolution of the little spiral nebula that is supposed to have grown into our planetary system.

When the passing star that incited the nebular deployment made its approach, its differential pull drew forth tidal "bulges" on the opposite sides of the sun. These were really cones rather than the broad bulges usually pictured, but superposed as they were upon a spheroidal surface they appeared as merely bulges, as commonly represented. The term cone, however, better represents their dynamic function. At the same time that the cones were drawn out on the line joining the sun and the star, a belt of inward pressure was brought into play at right angles to them. The joint effect of the protrusion of the cones and the compression at right angles to them was a concentration of the sun's eruptive tendencies into the cones. At the same time, the eruptive function was powerfully stimulated. As a result, the sun shot out gas-bolts from the quasi-volcanic cones whose mass was much greater and whose velocity was much higher than that of the eruptive prominences which are now shot forth at short intervals in a more sporadic way even in the absence of any such special outside stimulus or internal concentration. In the absence of a passing star these eruptions of course fall back to the sun. But if a bolt were shot far out toward the passing star, it

would be drawn forward by it. If only slightly drawn forward, it would return to the sun, but would carry back with it such transverse momentum as it had acquired. This would affect the rotation of the sun. The ejection on the opposite side of the sun would act in a similar way in accordance with well-known tidal principles. If the bolt were pulled forward sufficiently far it would fail to strike the sun on its return and would fall into an orbit about it. If the pull were effective enough, the projectile would not return at all to the sun but swing into an orbit about the passing star. If the respective pulls of the star and the sun against one another happened to be properly balanced, they would throw the projectile out of the control of both and it would go off into space and probably pass under the control of some other star.

Dr. Moulton traced out mathematically the courses of such projectiles in nearly half a hundred selected cases and found the process competent to give a wide range of results. In the first ten cases tried all of the contingencies just named were realized. The eccentricities of the orbits were often large, but the range of variation was such that when the many small bodies of the nebula were gathered into a planet the combined orbit would approach a subcircular form. The potency of the mechanism was found unexpectedly high; its efficiency as a pa·titive and distributive agency proved to be quite beyond anticipation.

It need not be urged that the solar eruptions under these conditions would be pulsatory, or that the gas-bolts would be subject to sub-fracturing and to the wide scattering of a part of their material. From such actions would arise "knots" of different orders and highly scattered "haze," the constituents which make up practically all spiral nebulæ.

This, then, is the mechanism to which is referred the origin of our planetary system. It is of vital moment to note just how those critical features in our planetary system that seemed to offer so serious objections tò the older hypotheses, are met under this interpretation. The gas-bolts shot out from the sun were, under the assigned mechanism, given transverse momentum by the attraction of the passing star. Thus the planets into which they were collected received their high endowments of moment of momentum, endowments that were proportionately of a much higher order than that of the sun. Some endowment was indeed received by the sun from the same source through the projectiles that fell back to it. The ancestral rotation of the sun is supposed to have been nearly opposite to its present rotation. The contribution of momentum from projectiles falling back first neutralized the sun's rotatory force and then reversed it, finally leaving it with the very slow rotation and slight obliquity it now has. As all the projected matter was shot either toward or from the passing star and was drawn forward in the direction of its movement, all the nebular orbits were in nearly

the same plane, and the nearly perfect disk of the final system was inevitable. Thus are explained the most radical features. The many other peculiarities of the system grew up as mechanical necessities in the subsequent processes of organization. Given a series of primary knots, the heads of the main gas-bolts of the more effective eruptions, attended by many sub-knots, fragments torn from these in the eruption, attended also by innumerable scattered particles ranging from molecules upwards, all thrown into elliptical orbits of varying eccentricities and slight deviations of plane, and the laws of mechanical aggregation did the rest. The primary knots were the predetermined nuclei of the planets. A multitude of lesser knots formed the nuclei of the planetoids. The secondary knots formed the nuclei of the satellites, while the highly scattered material of the haze was collected into the various nuclei and constituted the food for their growth.

Time forbids us to try to follow out the details. Though the scattered matter was originally molecular, it was neither gaseous nor meteoritic in any strict sense of these terms. It consisted of particles thrown into individual orbits of a common type moving in the same direction about the sun. The integers were thus from the outset of the dynamic nature of minute planets. To emphasize this radical feature they have been called planetesimals. The term embodies the soul of the hypothesis and suggests the dynamics that actuated the later evolution.

This evolution consisted of the natural and inevitable gathering of these planetesimals into the nebular knots serving as nuclei of growth forming ultimately planets, planetoids and satellites. The crossing of the initial orbits and the precessions and perturbations that inevitably arose from the interaction of various parts of the nebula, were the chief agencies in facilitating a gradual organization of the intertangled planetesimal system of elliptical orbits into the simpler and more harmonious sub-circular orbits of the present planets.

In the absence of time to delineate more fully this evolution, we may perhaps be pardoned an expression of the conviction that in the natural course of such evolution the many special features of the planetary system, not excepting its seemingly strange anomalies of rotation and revolution, find satisfactory explanation.[2]

Our special picture of the genesis of our planet, then, is that of an earth growing up about a nebulous "knot" through the rather slow accession of planetesimals, and taking on its mature form by gradual stages under general influences not radically different from those that presided over its later history, save in the gradual diminution of its rate of growth. Some of the salient features of this growth, some of the configurations that were acquired, and some of the dominant processes

[2] A fuller exposition of the hypothesis will appear in "The Origin of the Earth," a book about to issue from The University of Chicago Press.

upon which the planet entered, at maturity, will be the subject of our second lecture.

In a closing word, may I invite attention again to the essential simplicity of the assigned process of rejuvenation by which the sun gave birth to its present planetary family. It involves no postulate of general destruction and re-creation. There is no appeal indeed to any event that may properly be regarded as other than in the natural course of astronomic events. It is merely postulated that one of the simplest and most inevitable of astronomic events stimulated a partial deployment of the sun and gave birth to our modest little planet. The genesis of a planetary family was perhaps quite as much in the natural order of things in the heavens as was the initiation of a biological family in the course of terrestrial history.

IMMIGRATION AND THE WAR

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A CRISIS has been reached in our immigration policy. The war has, for the moment, very largely reduced the flow of aliens to our shores. For the first time in many decades we have breathing space. On the other hand, the effects of the war upon the peoples from which our future immigration will come are likely to be far-reaching. This fact will, after the war is over, bring us face to face with many new and difficult problems which need careful consideration at the present time. We must think clearly, decide wisely and act quickly. We need new immigration legislation. We need it at once.

Our present consideration naturally comes under three heads. First, the present status of immigration. Second, the probable future volume and character of immigration. Third, the necessary changes in our existing immigration laws.

The Present Status of Immigration.—From a total annual immigration of nearly a million and a half during the fiscal years 1913 and 1914, and an annual net increase in alien population (*i. e.,* deducting the numbers of those who returned to their own countries) of 800,000, the number of immigrant aliens fell to a little over 325,000 during the year ending June 30, 1915. Further, owing to the unusually large numbers who left this country, the actual increase in our population through immigration was only 50,000.[1]

During the months July to December, inclusive, the number of arrivals was 169,291; of departures, 166,899, leaving a net increase of population of 2,392. The war has thus brought us, suddenly and unexpectedly, face to face with a great experiment in restriction—restriction of a far more drastic sort than has ever been suggested by any but a few of our most radical exclusionists. Furthermore, the war has brought, temporarily, an interesting change in the racial character of our alien arrivals. The majority of those coming in recent months has been from northern and western Europe, whereas, under ordinary conditions, nearly three-quarters of our immigrants are southern and eastern Europeans. The British Isles, Holland, Denmark, the Scandinavian countries, from all of which there has been a fairly regular steamship service, have kept on sending us about their usual quota. Of those aliens who have returned home for military duty, the large ma-

[1] For the sake of simplicity, these statistics are given in round numbers.

jority came originally from southern and eastern Europe. Immigration restrictionists have observed with satisfaction that there has been less unemployment than usual during this winter, even in our large eastern cities, and realize, what they have always maintained, that reducing the inflow of unskilled labor must inevitably simplify and lighten all our burdens of public and private charity. They observe, also, that there has been no widespread, serious or disturbing lack of labor in our great industries or public undertakings. The predictions of those who have persistently maintained that even a very moderate restriction of immigration would immediately lead to a labor shortage and greatly curtail our industries have been shown to be in error. It is true that there has been somewhat of a deficiency in the supply of domestic servants, especially in New York City. This is partly due to the demand of the factories for more operatives. And in any case, the situation is not without its advantages, if it results, as it undoubtedly must, in more efficient and less wasteful housekeeping.

An important eastern newspaper, which has always strongly opposed the further restriction of immigration, recently lamented the fact that the present small alien inflow would result in somewhat higher wages for our laboring classes. This puts the case very squarely before us. Unrestricted immigration; lower wages; cheap labor; un-American standards of living, on the one hand. A reasonable selection and restriction of immigration; better wages; more intelligent labor; American standards of living, on the other.

The Probable Future Volume of Our Immigration.—Is immigration likely to be greater after the war than before it? Or are we to witness a general and more or less permanent decrease? Our economists are already considering this question, and Commissioner of Immigration F. C. Howe, of New York, has discussed it in several magazine articles. With most of Commissioner Howe's conclusions we find ourselves in general agreement. The demoralization of industry; the breaking-up of homes; the roving restlessness of millions of men who will never be able to "settle down" again at home; the greatly increased burdens of taxation; the desire to fly from the horrors of future wars; the political, religious and social readjustments with the almost inevitable oppression and dissatisfaction of multitudes of people; the widespread destitution, misery and hopelessness; the return to the United States of aliens who went home to fight and who will bring back with them many of their countrymen who have never been here; the desire of the foreign-born already in the United States to bring to America relatives and friends who are still left abroad—these and other causes will operate to bring us an increase in immigration which seems likely to surpass anything that we have ever known. It is easy to see what use the steamship agents

will make of the conditions following the war, in order to stimulate emigration from abroad. "Fly from the horrors of war; escape your taxes; go to a country where there are no wars; where there is no standing army; where wages are high and work is plenty; go to America." A considerable proportion of our immigration even in normal times is thus artificially stimulated. What will happen after the war it is easy to guess. Already, plans are being made by foreign companies for the establishment of new steamship lines, to bring emigrants from Europe and Asia to the United States.

All this is not mere idle speculation. Our statistics show that recent wars have in no case been followed by any permanent decrease in emigration from the countries involved. On the contrary, as Professor J. W. Jenks has pointed out, these wars have usually resulted in a large and almost immediate increase. After the Franco-Prussian war, immigration to this country from Germany and France increased, and attained its maximum not many years after the war. Greek immigration increased steadily after the last Turco-Grecian war. The more recent Balkan war was followed by increased immigration from the Balkan states. The numbers from Serbia, Bulgaria, Montenegro and Greece in the year after that war were nearly double those of the year preceding the war. Those who may maintain that immigration will decrease permanently after the present war is over have no statistics on which to base their claim.

On the other hand, of course, there will be tendencies which may operate to cut down emigration from certain European countries. An enormous amount of constructive work will have to be done, in the rebuilding of roads, railways, bridges, factories and dwellings, and in the general rehabilitation of what the war will have damaged or destroyed. Immense numbers of skilled and also of unskilled workmen will be needed for these enterprises. Owing to the thinning of the ranks of the most efficient laborers, by death or by injury, during the war, wages may perhaps rise, but whether the impoverished nations of Europe will be able to compete with our American wages, and thus keep their people at home, yet remains to be seen. Again, it is not unlikely that some of the European governments will take steps to discourage, to check, perhaps even for a time to prohibit emigration. The work of reconstruction after the war will go on most actively and most effectively in the countries of northern and western Europe, where the state and industry are well organized, and where the plans for reorganization will be carefully prepared. It is in these countries that there will inevitably be the most immediate and best paid opportunities for the largest number of laborers. And it is, therefore, from these same countries, from which we have in the past received our all-around "best" immigrants, that we

are likely to see the greatest falling off in immigration. On the other hand, in the countries of southern and eastern Europe and of western Asia, immigration from which has been on the whole more of a problem, because of the differences in race, political institutions, education and social habits, there will not be the same organized reconstructive work. From these countries, therefore, so largely in the more primitive condition of agriculture, the forces tending to promote emigration will be operative to a much greater degree than ever before. Thus the great preponderance of southern and eastern Europeans, already the most striking feature in our recent immigration, is likely to be still further increased after the war is over. To put it briefly, the centripetal tendency, to keep people in Europe, will be greater among the nations of northern and western Europe; the centrifugal tendency, to drive people out, will be greater in southern and eastern Europe, and in western Asia. Balancing the reasons for a possible decrease in our immigration after the war against those which will bring about an increase, the weight of probability is strongly on the side of a marked increase. This increase will doubtless for some years be largely one of women and children, whose care will throw a very heavy burden upon all our charitable agencies.

The Probable Future Mental and Physical Character of Our Immigration.—No one who has at heart the future of the American race can fail to view with concern the probable effects of the war upon the physical, mental and moral condition of our immigrants. The introduction of pestilential war diseases, such as cholera, typhus, typhoid fever and the like, is not greatly to be feared, although some of our medical men are already viewing this problem with much concern. On the other hand, the more subtle and much less easily detected venereal diseases, which are always rampant in great armies in war time, and the mental breakdowns, of which there are so many thousands of cases among the soldiers at the front, present another aspect of the health problem which is far more serious.[1] Great numbers of soldiers, although not actually afflicted with any specific disease, will eventually come to the United States, maimed, crippled, wounded, enfeebled by illness or exposure, or mentally unstable. The fittest, mentally and physically; those who in the past have had the initiative and the courage to emigrate, will be dead, at the prime of life, or will be needed at home to carry on the work of rebuilding and reorganization. These are the men whom Europe will do its utmost to keep at home. The least fit are likely to emigrate. Many of those who, because of mental or physical disability, will find themselves least able to earn a living abroad, will be the very ones most

[2] It is very significant that the final report (March, 1916) of Lord Sydenham's Royal Commission on Social Diseases dwells particularly upon the inevitable effect of the war in greatly increasing the seriousness of the situation.

likely to be "assisted" by relatives and friends in this country to "come to America." Against the emigration of such persons the European governments will not set up any barriers. There are good grounds, therefore, for expecting, with reasonable certainty, that our immigration in the next few decades after the war will be of a lower physical and mental standard than it has been in the past.

The moral effects of the war are by no means to be disregarded. As Commissioner Howe has clearly pointed out, a widespread demoralization will prevail among the peoples now at war, resulting from life in the army; the breaking off of family ties and responsibilities; the restlessness and difficulty of settling down again after the fighting is over; the craving for freedom and liberty as soon as the military discipline is relaxed. Our future immigration is sure to contain a large proportion of these disturbed, restless, irresponsible men; less amenable to law and order; less disposed to conform to our conditions of life; less easily assimilable, than has been the case in the past. The interruption of the education of multitudes of young men who have been called on for military service, and who will never take up again their scholastic or vocational training, is a serious phase of our general problem. This group will go forth into the world insufficiently and unsatisfactorily prepared for the business of life. For years to come, our immigration will include large numbers of youths and of men whose standards of education will be lower than would have been the case had there been no war.

And what of the more distant future? What of the effects upon the unborn generations? This question is obviously a difficult one. Opinions vary greatly in regard to it. As a rather extreme representative of one side, we may turn to Dr. David Starr Jordan's latest book, whose title clearly indicates the message which its author seeks to bring, "War and the Breed: the Relation of War to the Downfall of Nations" (1915). War, as Dr. Jordan strikingly puts it, "impoverishes the breed." The strongest and best men are the ones who are killed or injured, and who leave few or no children. The weaklings live, marry and continue the race. The result is an inevitable impoverishment of the stock. Dr. Jordan notes the reduction in the required height of French soldiers as the result of the Napoleonic wars and the killing off and wounding of the taller men. The French and German babies of 1870–71 who came to be mustered as soldiers twenty years later, were found to be an inferior lot of men. And, more recently, as noted by Dr. Jordan in *Science* (New York), a similar condition has occurred in Japan. The Japanese children born at the time of the war between China and Japan, twenty years ago, became conscripts in 1915. According to the *Asahi* of Tokyo, as translated in the *Japan Chronicle*, the number of conscripts in Tokyo decreased over 16 per cent. For Japan

as a whole there was an increase of conscripts in 1915, but the rate of increase was only 30 to 50 per cent. of the normal. Furthermore, a lowering in the quality of the new soldiers is distinctly observable. The *Asahi* says that "most of those who underwent conscript examinations this year were born during the war and therefore are sons of those too old or too weak to go to the front, and so it is no surprising thing if the conscripts of 1915 are of exceptionally delicate constitution." This "impoverishment of the breed," in Dr. Jordan's opinion, is an inevitable result of war. The longer the conflict continues, the more serious will be the effects upon future generations. The weakling fathers—too young, too old, or too feeble to fight—and the improperly nourished, overworked and harassed mothers of Europe, are handing on to their children who are now being born an inheritance of physical and mental unfitness which will mark not only this generation but future generations, through the long vista of the time to come. An increase in the number of defective children, now and hereafter, is a condition which Europe must face, and which, because it will affect the character of our immigrants, vitally concerns the United States. Dr. Aleš Hrdlička, of the Smithsonian Institution, one of our leading anthropologists, contributes to Dr. Jordan's book an opinion as to the probable effects of heavy artillery firing on the nervous systems of soldiers in the war. He believes that subjection to the constant roar of the firing will "result in a more or less defective mental or nervous state in the progeny of such individuals."

Dr. Jordan's view may be thought rather extreme. The problem is a highly complex one. There are not lacking those who take a different position. It is pointed out that wars have been so constant, not only in Europe, but over most of the world, that if wars do result in racial deterioration, national degeneracy should have followed them. Again, it is urged that by no means all of the physically and mentally fit who go to war are killed, or are so impaired in body or mind as to be undesirable fathers for future generations of offspring. The number and the quality of the men who will survive the war is at present an unknown and indeterminable element in the problem. Professor Roswell H. Johnson, of the University of Pittsburgh, has recently warned us[1] against sweeping and unqualified statements that war is either good or bad in its effects on the human race. Some wars are mainly good; others mainly bad. A conscripted army is likely to be physically, and probably also in other respects, superior to the bulk of the population. The conditions of poverty, improper sanitation and inadequate medical treatment in the homes tend toward a deterioration of the race. Many factors must thus be taken into account. In summing up his argument, Professor Johnson says:

[3] *Journal of Heredity*, December, 1915.

In the present war it would seem that the high quality of both sides compared with the rest of the world is so predominant a dysgenic factor that, together with the other dysgenic features, the eugenic results are overbalanced. The human species therefore, on account of this, is at present declining in inherent quality faster than in any previous length of time.

In connection with this particular subject, it is highly significant that Germany, which is universally recognized as preeminently the military power of the world, and whose scientific study of military problems is so thoroughly organized, should already be giving serious attention to the racial effects of the war. On October 26–28, 1915, there was held in Berlin, *a Tagung für die Erhaltung und Mehrung der deutschen Volkskraft*—surely a highly significant designation. Over one thousand delegates attended, and the proceedings were marked by an extraordinary unanimity of sentiment. It was recognized that "war kills the best, the bravest, the healthiest, eradicating once for all the finest strains of the race." There was serious discussion with a view to bringing about an increased multiplication of the fit by various means, chiefly the assistance of large families of healthy stock.

From the foregoing considerations it appears that the effect of the Great War upon the United States, will, unless all signs fail, be profound and far-reaching. For it will affect the mental, physical and even moral characteristics of millions of our future immigrants and of their descendants.

The Idealist and Immigration Restriction.—There is still in our midst a group of idealists who shudder at the mere thought of a further regulation of immigration. They hold fast to the vision of the universal brotherhood of man. They call "narrow," "ungenerous," "selfish," "un-American," any one who suggests further immigration legislation. They point out what an enormous debt our country owes to its foreign-born citizens. They never tire of reminding us of the remarkable achievements of foreign-born children in our public schools. They have absolute confidence in the strength of our institutions to assimilate all people, of every land, who may choose to come here. They believe that this is the world's great "melting pot," where race hatred and race differences are to be forever done away with. They produce such endless and impressive statistics to prove that our recent immigrants are far ahead of the native-born in all that pertains to good citizenship that we sometimes cannot help wondering how our ancestors, of Anglo-Saxon stock, who originally settled the United States, ever had the genius and the wisdom and the courage to fight the Revolutionary War, or to develop our American democratic government. They believe in keeping the United States forever the "asylum and the refuge for the down-trodden and oppressed of all nations." Wonderful ideals these are, and tremendously inspiring, when eloquently presented, is the

thought of the "haven of refuge." Yet those who hold these views, sincere though they are, are nevertheless inconsistent. Not one of them really believes in a "haven" open, unrestrictedly, to all comers. Not one really believes that we ought to admit, unreservedly, the insane, the idiot, the criminal, the prostitute, those who have "loathsome or dangerous contagious disease." There are probably none of them who want our doors wide open for all time for the incoming of millions upon millions of Chinese, Japanese and Hindus. They may think themselves perfectly sincere when they use the haven argument, but they are obviously not so. They really do not want their "asylum," of which they say so much, to become an insane asylum, nor their "refuge" to become an almshouse or a penitentiary.

Standing close behind these idealists—whom the late Gen. Francis A. Walker well termed "optimists beyond all bounds of reason"—and using the same eloquent and catchy appeals, come the manufacturer, the land owner, the contractor, the railroad and the steamship man—all profiting directly through the influx of unlimited "cheap labor"; all demanding more "hands," and most of them indifferent as to the conditions of the bodies and of the minds which of necessity go with these "hands." Our large employers of labor naturally enough use the "brotherhood of man" and the "haven of refuge" appeal. It blinds people to their real motive. Thus many of our idealists have been misled into cooperating with these "big money" interests, not realizing that the true motive which controls these is purely selfish. Another group which is strongly opposed to immigration restriction is made up of the leaders of our foreign-born colonies, mostly contractors, steamship agents, small bankers, newspaper men, and the like, all of whom feed on our recent immigrants and want the supply to continue as large as possible. And politicians whose positions depend upon the votes of foreign-born citizens constitute another small but very noisy group, also ranged behind the banners inscribed "Haven of Refuge" and "Asylum for the Oppressed." Professor E. A. Ross, of the University of Wisconsin, has clearly brought out one fact in regard to the idealists which is not generally appreciated and yet has great significance.

> The investor, landowner, and contractor can well afford to preach worldwide brotherhood. The professional man sitting serene above the arena of struggle can nobly rebuke narrowness and race hatred. Throughout our comfortable classes one finds high-sounding humanitarianism and facile lips of sympathy for immigrants coexistent with heartless indifference to what depressive immigration is doing and will do to American wage earners and their children. If the stream of immigration included capitalists with funds, merchants ready to invade all lines of business, lawyers, doctors, engineers, and professors qualified to compete immediately with our professional men, even judges and officials able to lure votes away from their own candidates for office, the pressure would be felt all along the line and there might be something heroic in these groups

standing for the equal right of all races to American opportunities. But since actually the brunt is borne by labor, it is easy for the shielded to indulge in generous views on the subject of immigration.

Necessary Changes in Our Immigration Laws.—There is one thing about our immigration legislation which it is essential to keep in mind. The whole subject is a very difficult one. To understand it one must know the history of immigration and of our immigration laws from the beginning; the regulations which at different times have governed the enforcement of these laws; the interpretations which have been put upon them by the courts; and the actual workings of the laws as compared with the way in which they were intended to work. For the layman to have knowledge of these facts is clearly rarely possible. And laymen who, without sufficient knowledge of the subject, write or speak on immigration legislation, simply add to the confusion, bring themselves into ridicule, and delay the enactment of proper laws. In this matter, as in so many others, the only way is to accept the conclusions of the experts. Our present immigration laws aim to exclude some twenty-one classes of mentally, physically, morally and economically undesirable aliens. On paper, the list of the excluded classes is long and formidable, and seems amply sufficient. But careful and unprejudiced students of immigration, both within the immigration service and outside of it, agree that we have not been keeping out the unfit sufficiently even to preserve the mental and physical *status quo* of our population, to say nothing of promoting any improvement. These laws grew up slowly, as the result of experience extending over many years. They have served as the basis for the immigration legislation of Great Britain and of Canada. They were not the result of any "know-nothing" agitation, of the sudden demand of a political party, or of the whim of a moment. As recently as 1875 we excluded only criminals and prostitutes. Slowly, deliberately, carefully, this legislation was planned and enacted. Nevertheless, the experience of years has brought the defects to light. Competent government immigration officials have pointed them out. Disinterested citizens, and economists, and medical men and social workers, have studied these laws, and have shown us where they fail to accomplish their purpose. The last few years have witnessed a very remarkable spirit of cooperation among our experts on immigration matters in the effort to frame new legislation which shall really be adequate to meet the conditions which experience has shown to exist. There is a bill now before the House of Representatives (H. R. 10384, Union Calendar No. 36, Report No. 95) which, all things considered, is the most comprehensive immigration bill ever introduced into Congress. It is the result of years of careful study of our present law and of its workings. Its provisions, as the commissioner-general of immigration says in his last annual report (June 30, 1915), "contain

the result of experience and investigation—of the experience of administrative officers, extending over nearly a quarter of a century, in the enforcement of various statutes regulating immigration, and of the investigations conducted variously but in particular by the Immigration Commission, created under the act of 1907, the report of which, comprising 42 volumes, was submitted to Congress in December, 1910." The provisions of this bill "have been drawn with great care and thoughtfulness, . . . by them the law is made certain in its definitions and clear in its term throughout—improvements badly needed in the existing statute." The bill aims to protect the United States against the incoming of mentally and physically, and of otherwise unfit and undesirable aliens. It also embodies several provisions which would ensure more humane treatment to the aliens themselves, and would, to a large extent, do away with the hardships involved in the deportation of aliens who are excluded at our ports, by preventing their original embarkation. And in response to the ever increasing demand—greatly strengthened by the probable effects of the war—for the further restriction of economically undesirable immigration, the bill also proposes certain amendments designed to keep out some of this group.

The bill is largely a codification of our existing immigration laws, but embodies several important new provisions. It is clearly out of the question to discuss this bill, which covers 62 pages of print, in detail in the present article. It is our purpose merely to call attention to a few of the more important changes which its enactment would make in our present laws, but with special reference to the exclusion of the mentally and physically unfit. In regard to the better detection, exclusion and deportation of this group there is no essential difference of opinion among those who have the future of our race at heart. The unanimity of feeling in this matter is encouraging, but, in view of our past experience with mentally and physically defective aliens who have been admitted to this country, it is not surprising.

To the excluded classes the bill adds *persons of constitutional psychopathic inferiority* and *persons with chronic alcoholism,* both of which designations have a definite meaning to alienists, and to the surgeons of the United States Public Health Service. That many persons not properly to be certified as insane but who would, in many cases, become insane soon after arrival, could be kept out under the former provision, has long been the opinion of the physicians, the alienists and the immigration officials who have made a special study of this subject, and who have for years strongly urged the inclusion of this new provision in our immigration law. Chronic alcoholics, who are surely undesirable members of our community, are often discovered by our examining surgeons, but as the law does not now state specifically that

they shall be excluded they must in most cases be allowed to land. The new bill excludes *vagrants*, and *persons afflicted with tuberculosis in any form.* It also aims to prevent the embarkation of aliens afflicted with idiocy, insanity, imbecility, feeblemindedness, epilepsy, constitutional psychopathic inferiority, chronic alcoholism, tuberculosis in any form, or a loathsome or dangerous contagious disease, by imposing upon steamship companies who bring such aliens a fine of $200 plus the amount paid by the excluded alien from his initial point of departure provided the secretary of labor is satisfied that the defects could have been detected by a competent medical examination before embarkation. This is an excellent and humane provision, and would go far toward making these companies more careful in the sale of passage tickets, and would save many unfortunate aliens the disappointment and hardship of being deported after arrival at our ports. The present fine is $100, has been shown to be too small to be really effective, and does not cover as many cases as are above enumerated. A new fine of $25, plus the alien's transportation expenses, is established in cases of certain other less serious mental defects, and of physical defects which may affect an alien's ability to earn his living.

The new bill provides for a very much more thorough medical examination of arriving aliens, especially with reference to the detection of mental diseases; gives the medical inspectors the exclusive services of interpreters, and suitable facilities for the detention and examination of the aliens. This amendment has been strongly urged by the united action of the most important scientific bodies in the United States which deal with the prevention and treatment of mental disease, by state medical associations and by individual physicians all over the country. That our medical inspection has been hopelessly inadequate has long been known to the experts. We have not had enough medical inspectors, and those on duty have not had adequate facilities for their work. Thus it has come about that, in spite of our law prohibiting the admission of insane and mentally defective aliens, our institutions have been filling up with just these people. As Dr. T. W. Salmon, of the National Committee for Mental Hygiene, has well said:

> There is no reason for the acceptance of a single insane or mentally undesirable alien except inability to determine his condition.

It is a very significant fact that, with the decrease in immigration since the war, particularly at New York, a more rigid medical inspection has become possible. This "intensive examination" has resulted in a marked increase in the numbers of aliens certified as having physical or mental defects. "Certainly," says the commissioner-general, "there could be no better or more convincing argument . . . for increasing the medical force sufficiently to insure that no alien shall be admitted to the

country until he has been subjected to a medical inspection really calculated to disclose his mental or physical deficiencies." With this statement all public-spirited citizens will surely agree.

The new bill extends from 3 to 5 years the period during which aliens may be deported who at the time of entry belonged to one or more of the excluded classes; who have become public charges from causes existing prior to landing; and of some other groups. This extension of the deportation period has been urged, year in and year out, by heads of institutions who have had to do with dependent, defective and delinquent aliens, by organized charitable societies, and, perhaps most strongly, by the former commissioner of immigration at the port of New York, Hon. Wm. Williams, whose thorough, sane and illuminating study of the whole immigration problem has contributed greatly to our understanding of the subject. It is the conviction of all the unprejudiced experts who have studied this problem that a five-year deportation period would relieve our penal and charitable institutions of an enormous financial burden, reaching into the millions of dollars, and would rid our communities of large numbers of defectives who otherwise would remain here, many of them a burden upon state or city, and many of them starting long lines of defective and delinquent children.

The new bill strengthens the provisions of existing law regarding the "White Slave" traffic; makes the inspection of steerage quarters more thorough; compels steamship companies, when deporting aliens, to give such aliens as good quarters as those for which they paid on the voyage to this country; makes possible the expulsion from the country of alien anarchists and criminals, even when they have become such after entry; and in many other ways provides for the welfare of the alien as well as for the welfare of the United States.

All these new provisions regarding the more effective exclusion and the deportation of mentally and physically unfit aliens have been carefully drawn, as above stated, after consultation with experts who have seriously studied these particular aspects of our immigration problem. They were all suggested and strongly urged upon Congress years before the war broke out. Their enactment into law should have been effected long ago, under the usual conditions of normal immigration. But every argument in favor of this legislation has gained weight, incalculably, in view of the probable effects of the war upon the character of our future immigrants. As the commissioner-general says in his last annual report, the adoption of these amendments now "becomes an imperative necessity." It is for the best interests of our future race; it is for the best interests, in the long run, of humanity at large, to prevent, as far as may be possible, the coming to this country of the mental and physical derelicts of the war. It is unfair and ungenerous

to future generations of Americans to saddle upon them the tremendous burden of supporting not only the present generation of these people, but the long lines of their descendants. It is not doing our share in the promotion of race betterment if we, who have the matter in our own hands to-day, do not act at once, before it is too late.

The demand from the country at large for a further restriction of immigration which is "economically undesirable" has resulted in the inclusion, in the pending bill, of certain provisions which aim more or less directly at restriction, whereas the amendments above considered, relating to mentally and physically unfit aliens, are rather matters of the public health and safety than of a large regulation of immigration. It is clearly the temper of Congress as shown during the past few years, to combine all immigration legislation into one general bill. Hence we must consider briefly the provisions which have an economic, as well as those which have medical bearing.

The new bill excludes Hindus, whose immigration has only recently begun, but whose coming in inevitably larger and larger numbers will, if unchecked, lead us into many serious racial and economic difficulties. It increases the head tax from $4 to $8, but exempts children under 16 who accompany their father or mother. Under the present law, every alien, even an infant in arms, is required to pay a tax of $4. In practise, however, the tax is paid by the steamship company, and is not a provision oppressive to the arriving alien.

The new bill provides for a reading test, in a very mild form, by excluding "all aliens over 16 years of age, physically capable of reading, who can not read the English language, or some other language or dialect, including Hebrew or Yiddish." Sweeping exceptions are made in the case of fathers and grandfathers over 55; wives, mothers, grandmothers, unmarried and widowed daughters; and of all aliens who are fleeing from religious persecution abroad. This is not the place to present any argument in favor of the reading test. It was recommended by 8 out of 9 members of the U. S. Immigration Commission "as the most feasible single method of restricting undesirable immigration." It has been endorsed, over and over again, by state legislatures; boards of charity; philanthropic organizations of all kinds; labor bodies; chambers of commerce; by our leading authorities on immigration and by citizens in all walks of life. In the past twenty years a reading test, often in a more severe form than the one at present proposed, has passed one House of Congress or the other more than twenty times. It has been truly said:

> If ever the citizenship of the United States has given endorsement to any measure of legislation, it certainly has done so to the principles embodied in this bill.

Of course, to object to the reading test on the ground that it "will not exclude the educated rascal" is a sign either of gross ignorance or of a wilful attempt to mislead. The reading test is not to replace any existing provision of the present law. It is to be added to our present provisions. Criminals are already mentioned among the excluded classes, and we keep them out when we can, and as well as we can, although everybody familiar with the law, and with the difficulties of its enforcement, knows perfectly well that we really have no effective means of keeping out this group. No one maintains that the reading test is an ideal, or a perfect "solution" of our problem. As the editor of the *Review of Reviews* recently wrote:

> The application of new tests could be made now with less practical inconvenience than at a later time. That of ability to read is far from being a logically perfect one; but it was recommended by the Immigration Commission, several years ago, after a vast and impartial study of the whole problem. It is not likely that this test would operate to shut out very many desirable immigrants. It would, however, affect appreciably that great tide of labor that moves back and forth in the steerage, retaining its citizenship in the countries of eastern and southern Europe. The literacy test could be so modified and applied in a reasonable spirit as not to exclude many families whose addition to our citizenship is to be encouraged.

And Dr. Edward T. Devine, than whom we have no higher authority on all matters of public and private philanthropy, has, in endorsing the reading test, expressed similar views.

A bill containing a similar provision was vetoed by President Cleveland March 2, 1897, partly because of an objectionable clause which would have led to friction with Canada; was promptly passed over his veto by the House, and would have been passed over the veto by the Senate if it had not been crowded out by a tremendous pressure of business just in the very last hours of that Congress. The pending reading test is much more liberal than that of twenty years ago. There was not the same reason for it then as there is now. *And President Cleveland said, after the expiration of his term, that his veto of that immigration bill was one of the great regrets of his public life.* In February, 1913, a general immigration bill embodying a reading test passed both Houses of Congress by an overwhelming vote, and was vetoed by President Taft. Instead of writing his veto message himself, President Taft sent to Congress a memorandum written by his Secretary of Commerce and Labor, Hon. Charles Nagel, of St. Louis, who had always been strongly opposed to any really effective regulation of immigration. This bill passed the Senate over the veto by a vote of 4 to 1, and was lost in the House by only a few votes less than the necessary two thirds.

During the last Congress (sixty-third) a very similar bill passed the House by a vote of 2 to 1; the Senate by a vote of 7 or 8 to 1; and only

failed by a few votes of passage over President Wilson's veto. The latter was based partly upon a clause in the bill which seemed to the President to take away the right of asylum in this country for political refugees. This matter has been remedied in the present bill.

Thus the pending bill comes up before Congress once more, embodying provisions for the preservation of our public health by more effective exclusion of mentally and physically undesirable aliens; providing for more humane and fairer treatment of the aliens themselves; and excluding certain additional groups which, in the opinion of our immigration experts, are economically or racially unfit. It is natural that so complex a bill, codifying all our existing immigration laws, and making changes in them, should meet with opposition. Some of this opposition is honest and sincere. Much of it is based on misconceptions of what the present law is and of the ways in which the new bill would modify it. Much of it is the result of agitation by "interested" persons who do not hesitate to mislead the foreign-born members of our communities by wilful misstatements of facts, and deliberate falsehoods regarding the actual wording and purpose of the bill. When no less eminent a citizen than Cardinal Gibbons was misled into thinking that the immigration bill which passed the last Congress required ability to read *English,* it is not surprising that the great masses of our recent immigrants are even more mistaken. Much of the opposition, now as always, comes from the railroad and steamship companies, and from the large employers of labor. Some of it is coming from the Japanese and the Chinese.

In the midst of all this tangle, it is the business of those of us who know the facts, and who understand the purpose and meaning of the new bill, to keep our minds clear and sane; to urge, insistently, that more attention ought to be paid to the needs of the people of the country as a whole and much less to the meetings, and speeches, and noisy "resolutions" of this or that group; to point out that the mental and physical welfare of the future American race should first of all be safeguarded, and that the demands of any local, or temporary, or selfish, or narrow interest are not for an instant to be put ahead of this, the most important of all our national responsibilities.

BUILDING AND LOAN ASSOCIATIONS THE SOLUTION OF THE RURAL CREDIT PROBLEM

By Professor WILBUR O. HEDRICK
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THE enjoyment of his personal credit has become a matter of larger concern to the thrifty bread winner during recent years than was formerly true. The limiting of liability for collective indebtedness and the abolishment of prison sentences for debt, which took place simultaneously in civilized countries a half century ago, did much to relieve the odium and danger which prior to this time had attended using one's credit and made borrowing—especially for productive purposes—not only permissible, but actually commendable.

The opening of this newly approved field of opportunity was at once taken advantage of by many new credit-handling organizations. Banks increased in numbers wonderfully and, in addition to banks, trust companies, savings banks, building and loan associations, investment companies and many other credit agencies of lesser note came into existence for the handling of certain special supplies of or demands for this great resource. Credit is, indeed, in all its aspects essentially of the same nature—the transfer of something of a valuable character to another without an immediate equivalent in return—and it has as many varieties as there are credit agencies, or, literally, as there are uses or supplies. Thus there is bank credit, building and loan credit, merchants' credit, and, more technically, short or long credit, secured and unsecured credit and many others reflecting the effects of multitudes of practical influences.

The farmer's need for credit is of a highly specialized sort. The canvass of the credit needs of the farmer made by the Department of Agriculture in 1912–13 shows that it is customarily a period of from four months to four years which measures the length of the loan which farmers desire to make. The credit loans made by farmers for the shorter period is in the nature of advances upon crops for the growing of which the farmer is naturally short of means at seed time, but is opulent at time of marketing, for carrying cattle through feeding time and, in short, for defraying current expenses. The longer period of credit loans is for buying land, building silos or for making other permanent improvements. It will be seen at once that the farmer's use of credit is for investment purposes and that his patronage of customary banking agencies helps but little the store of liquid assets which are indispensable to the successfulness of the ordinary commercial banks.

The ordinary commercial banks are indeed limited by many handicaps in their dealings with farmers. In addition to purveying a variety of credit, which at its best is absolutely useless to farmers, commercial banks have an expensiveness of management which increases materially the cost of borrowing to the farmer. The up-to-date consumer and producer of commodities everywhere believes firmly that a cause of the current high prices of commodities may be found in the existence of too much interference, too much friction, too many hindrances (as a result of our middleman system) in the passage of products from their place of origin to their place of consumption. May not a similar explanation account for the high charges which bankers make for the transfer of credit from the hands of depositors to the hand of borrowers? Expensive legal regulations, for example, restrict the banker in all directions. He is legislated upon with regard to inspection, to his reserves, to his ownership liabilities, his interest charges, his mortgage foreclosures, limitations of loans to borrowers, creditability of farm lands to one half value, form of bank issues, character of securities, etc. An examination of these typical regulations will show that most of them are framed in the interests of the depositors and have for their purpose the worthy object of insuring a bank's business safety. But are such safeguards necessary for credit agencies which deal only with farmers, and should the countryman pay the increased price for his loans caused by the regulations which are intended as safeguards against the more speculative business of the city?

So small a point even as that of variation in business habits on the part of farmers and bankers tends constantly toward the estrangement of these two classes each from the other. The farmer is proverbially lax in keeping appointments with a bank, but the bank proverbially is adjusted to methods of punctuality. Most farmers also wish the cash itself when borrowings are made from banks, instead of merely credit; on the other hand, bankers wish to loan credit and are loath indeed to allow cash to be taken from their possession. Little frictions of this sort, however, are not, in fact, irremediable, but the serious one of applying an agency adjusted to the demands of one occupation to performing a service for another and very different occupation does not seem easily capable of reconciliation.

The penitential self-searching which our nation gave itself a few years ago in carrying out the far-famed conservation movement resulted in a few things which promise to be more lasting than the discovery of agricultural credit. It is true that farm credit had not been unknown among our many economic resources prior to this time, but it required the stress of a national hunt seeking our most remote and minutest assets for conservation purposes to bring out this great utility and reveal its actual proportions and real importance. It is with the con-

servation movement then—conservation of our human as well as our natural resources—with its problems of reforestation, of slum recovery, of desert reclamation and white slavery that the question of rural credit comes up.

A contributory reason for the appearance of this question among us, furthermore, is found in the enormous growth in value attained by farm property in recent years. The census of 1910 shows that during the preceding decade farm land had increased in value more than 100 per cent., and that the annual agricultural output had grown from about four billions in 1899 to nine billions in 1910. It has now grown to many more billions than this, with corresponding increases in the value of land. The existence of so much negotiable wealth in any occupation must necessarily add immensely to the credit possibilities within that occupation over what had previously prevailed.

The handling of the credit which arises from this stupendous amount of wealth has rested mainly in the past with the ordinary commercial banks of the country. The growth in numbers and profitableness of these institutions—national, state and private—within the last decade and a half is looked upon everywhere as phenomenal and little doubt can be felt by any one that much of the prosperity which this banking pursuit has enjoyed is derived from the increasing prosperity of farmers. The commercial banks indeed have been wide awake to the possibilities of this new field of credit resource—especially from the standpoint of its furnishing a new source of credit supply or deposits. In addition to the usual advertising, for example, which banks of all sorts put out to secure customers, bankers' organizations, both state and national, have in recent years appointed active committees upon agriculture to look after this interest in connection with their occupation, one or two agricultural banking periodicals have come into existence, local bankers have been among the chief promoters of the county farm agent undertaking in our various counties and banks everywhere vie with the railroads in the promotion of agriculture in the different neighborhoods through financing dairy-yield rivalries or alfalfa- and corn-growing contests.

The outcome of greatest note from the abnormal credit conditions described above has been the enlistment of the national government in the cause of improved rural credit. The Washington authorities have actively sympathized with the improvement of farm credit facilities for at least two reasons. First, because it was thought that better credit to the farmers would better agricultural production and lower the cost of living; and, second, because an improved supply of long-time farm credit might stop the spread of tenancy which is now so menacing, through allowing more farmers capital wherewith to buy farms. A gathering of the House of Governors considered the proper steps to be taken upon this matter in 1912, and two great commissions were sent abroad

by the combined state and national governments a year later to study the problem in Europe. The report to Congress of one of these commissions embodied a bill which provided for land-mortgage banks chartered by the federal government which should be similar in character to those of European countries. This bill was actively considered by congressional committees during the entire year following a promise from the administration in connection with the enactment of the federal reserve law, that rural credit legislation should be immediately taken up for adoption under a separate bill. The president's annual message also strongly urged the adoption of rural credit relief. In spite of this promise and this message, the rural credit bill was finally shelved so far as the first Wilson congress was concerned, by a congressional caucus late in the session. The Congress which ended last March appointed finally a commission, which should hold recess "hearings" and bring in a satisfactory rural credit bill at the commencement of the present session.

The improved rural-credit plan toward which the government is tending with its approval is the land-mortgage bank scheme, so conspicuously successful in European countries during recent years, and taking form in Congress through the provisions of the Bulkly-Hollis bill. These banks are at present with us invariably the product of state legislation. They are subject to ownership by private corporations and, in some instances, use state facilities in carrying on their work. Although varying slightly in details in different localities, their methods of operation are universally similar and may be quickly described as endeavors to transform a farm's creditableness into a shape available for purchase by the investing public. This is accomplished uniformly in the same fashion, namely, by taking mortgages upon farms (the loans secured by these mortgages being in the interests of the borrower of the installment payment type) and upon the aggregate security of these mortgages selling bonds in such denominations as best suits the investing customer. The bonds run for a limited number of years and bear such a rate of interest as will enable the bank to make a profit between the interest receipts received upon its mortgages and the interest rate paid upon its bonds. These banks market their own bonds without the aid of a central institution and make mortgage loans over a limited territory.

Let us now turn to an examination of the fitness of these land mortgage banks in comparison with their rivals, the building and loan associations, to undertake successfully the handling of the rural credit situation. Building and loan associations were first organized in Philadelphia in 1831 by working men, and, as their name implies, they are credit-furnishing societies rather than credit accumulators like the savings banks. They are cooperative in form of organization, and their funds are obtained from loaners who are seeking long-time investments. They have already become so thoroughly established among our credit

handling agencies that most states have provided special laws for the incorporations of these societies and special methods for their supervision. Their growth has been phenomenal, the hand-book for the national gathering of these associations for 1913 showing an aggregate of more than six thousand societies with a sum exceeding a billion of dollars equalling their assets.

Both kinds of institutions we notice at the first glance are similar to each other in the important fact that their loans are repayable upon the installment plan—the land-mortgage banks using as an amortization scheme of arranging its installments while the building and loan companies employ the scheme of the sinking fund. The land mortgage banks, indeed, have a decided superiority over the loan companies in this matter of installments through the greater simplicity of the contracts which they offer to the borrowers. The extreme simplicity of the amortized installment arrangement which the land banks use may be quickly grasped by any one accustomed to paying debts, but the building and loan method of using stock as a means to offset a loan is novel, and its merits are only seen after much explanation. Indeed, it is authoritatively claimed that a governmental subsidy to building and loan associations could not be used to better purpose than in conducting an educational campaign by which people generally would come to understand these institutions.

The loan societies and the land banks have both at bottom identical purposes, since both are largely agencies for the collection of money for certain definite uses, but the loan associations do this by selling stocks, the land banks by the sale of bonds. Unquestionably, the well-known characteristics of each of these two kinds of securities act in a similar fashion when applied to loan companies and land banks as when applied to any other type of corporation. The purchaser of a bond looks primarily to the security of his investment. He wants an assured interest income together with certainty of redemption of his bond at maturity. The buyer of a stock, however, is willing to assume a risk in the hope of possible gain. He takes things on a contingent basis. He wishes to participate in the business itself and the building and loan societies may properly benefit from this fact that its members, being stockholders, may be expected to give their common institution its much needed asset of publicity, while this end is attained by the land banks only through the use of the customary advertising.

It is sometimes assumed that mortgage banks have an advantage over building and loan companies because bonds have a more universal market than have stocks—the bond buyer, it is claimed, being only slightly interested in the management of his company, may live anywhere, while the stockholder seeking the highest contingent returns must live in the neighborhood of his property where he may have over-

sight of the administration. Substantial devices exist, however, whereby the loan society may reach out for a wider market than would naturally seem possible—such, for instance, as the sale of paid-up stock or the change from a local into a national society. The marketing successes of the two sorts of companies may be further characterized by the observation that building and loan companies have already made their reputation with the public in this country and the governmental administrative machinery for their control has become well established. On the other hand, the land banks, to a large extent, are still novelties unknown upon the markets and must yet commend themselves to the public in order to sell their bonds.

In the vital matter of expensiveness of loans, building and loan charges for a long-time debt are doubtless lower than are those of the land bank companies because, while the interest charges upon loans will be the same in both cases, the building and loan system of using a sinking fund with which to cancel a principal gives the borrower the earnings of this fund and may therefore reduce his total indebtedness.

Some problems there are in which both sorts of institutions are concerned, and in the interests of a full presentation of our problem these common grounds also must be described. Both, for example, are similarly interested in the question of freedom from taxation. It seems a slight subsidy indeed to request at the hands of government that institutions having such laudable purposes as the furnishing of homes or farms to people should be exempted from the usual public burdens. This consideration indeed receives added force when we remember that homes and farms are the very kinds of property which governments enjoy taxing to the uttermost, so that the eventual issue from the work of credit companies is to increase the field of revenue receipts for governments.

The problem of standardization of type for both the loan companies and the land banks is one which presents many perplexities. No other merit is more frequently assigned to the federal bill for chartering land banks than the one that it gives a federal charter whereby all of these banks will be uniform throughout the land. This uniformity will of itself, it is claimed, give standing and reputation to the concerns involved, since application merely of the same name, not to mention other opportunities, to the same institution everywhere will develop public familiarity which will be invaluable for security marketing purposes. On the other hand, the proposition which is frequently made to have the bond selling for these banks performed by a single institution within each state is very vigorously condemned, since it is asserted this will allow no flexibility between different parts of the state having different degrees of economic development as to interest rates, time terms, commissions, etc. Evidently this problem of flexibility or uniformity is

one of much delicacy. The loan societies have tended always toward flexibility, and they have doubtless benefited from this adaptiveness. We find no uniformity of name, for example, among these societies so that the same type may be designated by a different title in every different locality. In New England, as a case in hand, they are Mutual Savings banks, here in the Middle West we name them Savings and Loan societies or Building and Loan societies indifferently; their business processes vary incalculably, seventy methods of premium determinations are in vogue and almost half as many for distributing profits. It is quite within the range of doubt that so much variety is necessary and it would seem clear that some of the benefits claimed from uniformity by the banks would apply to loan societies also should they conform more closely to a single type.

The suitability of building and loan societies for furnishing rural credit is indeed no longer a mere academic question. They have already entered this field, particularly in the state of Ohio, where a recent report from the secretary of state for the commonwealth shows that more than fifteen millions of dollars are loaned by these societies for the purchasing of farms. It has been the business of these associations everywhere from the start to find creditability in the laboring man and to allow the laboring man the enjoyment of his creditability. They will be equally successful in discovering the credit resources of the farmer. Credit is proverbially shy and credit relations which are to endure for a half generation or more will not be entered into as readily with some new creation of law as with some association which has already solved the practical problems involved in legal, political and business adjustment. Furthermore, since loan associations are invariably cooperative in character they will form still another opportunity for this species of associative activity which is now regarded everywhere as indispensable to the farmer's development.

Apparently it is regarded as imperative that Congress shall provide some source of credit to the agriculturist during its present session. Ought not our lawmakers to throw such support as they are prepared to give for the improvement of rural credits in the direction of building and loan associations rather than toward mortgage banks? As we have tried to show, loan societies are strictly American in their origin, are specialized to long-time easy payment loans, have become thoroughly adjusted to our legal system and business methods, are reputable and have shown practically their successfulness in performing the work at hand.

THE MENACE OF ACADEMIC DISTINCTIONS

BY C. G. AND C. B. MACARTHUR
URBANA

IT has been eleven years now since the late William James wrote in his incisive essay on "The Ph.D. Octopus":

> America is thus as a nation rapidly drifting towards a state of things in which no man of science or letters will be accounted respectable unless some kind of badge or diploma is stamped upon him, and in which bare personality will be a mark of outcast estate. It seems to me high time to rouse ourselves to consciousness, and to cast a critical eye upon this decidedly grotesque tendency.

High time eleven years ago! No less urgent, certainly, has become the present necessity for such criticism. James continues:

> As it actually prevails and grows in vogue among us, it is due to childish motives exclusively. In reality it is but a sham, a bauble, a dodge, whereby to decorate the catalogues of schools and colleges. . . . In the minds of presidents and trustees the Ph.D. degree is in point of fact already looked upon as a mere advertising resource, a manner of throwing dust in the public's eyes.

James probably meant to include with the Ph.D. degree not only other cherished differentiations between the learned and the "rank and file of the common people," but also those slighter differentiations within faculty groups which cause the teaching force of our universities and colleges to "play politics" as basely as any ward politician, though more subtly as befits their greater culture, and make men prostitute their talents to gain recognition from their superiors in rank.

We in America have made perceptible progress toward democracy, but at times it seems as though the fewer and less striking became the acknowledged distinctions in society, the more doggedly did man insist on being differentiated from his fellows. It is a very common characteristic, by no means confined to academic circles; nor does it, as we in academic circles should like to believe, pass us by. Even those of us who harangue about the absurdity of degrees and titles feel snobbishly superior to those who bow before them.

Any one now may enter the class of the so-called intellectuals; but once there, he must, on pain of ostracism or expulsion, don the garb of the new class he has entered at least once a year. Slowly and solemnly he must walk, clad in a sombre black having red, yellow, purple, green, and salmon pink decorations, a being set apart, by the grace of God and the aid of a mortar board, from his less intelligent fellows.

There has been of late a healthful breaking down of some class

defenses. The scientists and dramatists have routed the doctor a little way out of his mysterious sanctum. The minister, tired of being classed a member of the third sex, has shed his "Reverend" and his coat tails. To be sure many people still have a confidence in their family doctor that would flatter the Almighty, and there is still many a woman whose awe for the minister can find no expression save in bounteous chicken dinners.

Among the academic class there are, to be sure, men of simple purpose, who have no desire to stand apart from their fellows, who ask only the stimulus and satisfaction of applying their accumulations of knowledge and adroitness with problems to the new and vital situations of our day. On the other hand, there are among this class those whose snobbishness tends greatly to limit their usefulness. Every class, of course, has its snobs; but when exclusiveness crystallizes into institutions—external symbols which the entire group accepts and the newcomers into the group are compelled to adopt, there is grave danger.

One wonders why the academics should be so jealous of their titles and honors and position. Business men manage without titles; likewise engineers and many others in professions calling for much training and keen intelligence. Yet here is a group who presume to set themselves apart and insist on being addressed in terms equivalent to "Your more or less Intellectual Highness." The mild insistence on the use of such terms by students, of course, might have its foundation in a desire so to overawe the student that he dare not do a disrespectful amount of independent thinking, nor call into uncomfortable question the authoritative statements of his lecturer; but why exact this deference from fellow townsmen or academic brethren?

This jealous guarding of titles and honors by the academics is, in part at least, due to an ideal which is developing in this democracy of ours—the ideal of an intellectual aristocracy. We have foresworn aristocracy of blood; we are outgrowing aristocracy of wealth; but there have been few to cry out against this new aristocracy that is being foisted upon us.

"Let those of us who know most," say the followers of this ideal, "determine what is best for all the rest of you. We know what the world has already attempted, what has failed, what has succeeded. Let us direct your efforts." One professor's wife complained, "It's a great pity the townspeople take the attitude they do; they not only refuse to take our advice about how the schools should be managed and the garbage collected, but they seem actually to resent our thinking we know best."

The academics are fostering the ideal of an intellectual aristocracy for exactly the same reasons that make a king favor aristocracy of birth, or that throw Wall street into a panic at the thought of federal control of our currency system. Members of each class are fully persuaded that it is best for society as a whole that their influence and power should

be dominant. It is amusing to notice that though the lines of demarcation drawn by any ambitious group between themselves and other groups vary, those lines have this in common—they never exclude those who draw them from the higher classes.

Such an attitude—that of the intellectual aristocrat—makes for inefficiency in a teacher, of course; for it implies lack of respect for the mental power of most of one's students, with resultant dogmatism.

We have gone mad these days, in university circles no less than in business, over specialization and efficiency. In so far as we are true democrats we must believe that the highest efficiency of any people is to be measured by the efficiency of each individual of that people. And that on no account means an efficiency which falls short of individual initiative and independence of thought. Dogmatism is intolerable in any institution, particularly intolerable in an institution on which the future of our democracy rests as it does on our universities. They need to make sure both that they are not dogmatically instructing students as to what they shall believe, and that they are not encouraging the idea of the divine right of one class to dominate another because of special training or technical information. We are struggling too severely these days to bridge the gap in sympathy between the capitalist and laboring classes to allow opportunity for other breaches in mutual understanding and sympathy to develop. It is because the childish academic distinctions that run riot in our universities to-day tend to widen the gap between the so-called intellectual classes and their fellows that they "give us pause."

In his "Great American Universities," Slosson unburdens his soul after this fashion:

> So it is with self-distrust and pure despair that I dismiss the subject after recording my personal opinion that a dozen mortar boards on the campus are more of a menace to democracy than a million-dollar endowment from a trust magnate. For no man can tell what use is going to be made of his money after he has let it slip out of his own hand, but a widespread spirit of exclusiveness and arrogance, such as find expression in ceremonies and costumes, can not be eradicated.

Aside from titles and "ceremonies and costumes" by which the academics proclaim their separation from the rest of the world, a technical vocabulary is in some measure responsible for this separation. A man may have a democratic, cooperative attitude in his secondary interests, but let another man speak a new truth in his chosen field, and he fails utterly to understand or credit him, if the other is unable to use the technical terminology of his science. We seldom realize how far from untrained minds the customary logical arrangement and terminology of a subject removes the academic. He frequently does not need tassels, or stripes, or a succession of capital letters after his name to make him immune to the ideas of the man of the street. This failure

to understand the other's vocabulary makes more difficult not only the acquisition of new ideas in their crude state by the academic, but also his dissemination of knowledge.

The profession of teaching is nearly always underpaid, and men have perhaps felt some compensation in the way of honor was due them. Society seems to say: "Gentle sir, we recognize your noble, self-forgetful spirit which is content only to teach and inspire our youth with no hope of reward other than a bare living wage. We are not ready to pay you more, but we will cheer you on by giving you high-sounding titles." The consequences of this policy have, however, been disastrous. By and by the self-forgetful man begins to listen for those titles; then to take to himself honor for his missionary spirit.

The truth of the matter is, much of the spirit of self-sacrifice has vanished from our university faculties to-day. Why, then, this additional compensation? It is absurd to call a man self-sacrificing because he prefers freedom for productive work, for self-expression, to the rewards of the business world. One should as appropriately honor a fan for his sustained devotion to baseball!

Eager as the academic is to keep at respectful distance the man of the street, this eagerness is frequently less fierce than his zeal for discrimination between himself and other academics. The contagion wards in a hospital are isolated with scarcely more care from one another than are the various ranks of academics, in catalogue (we make grateful exception of the University of California) and processions. Titles are jealously guarded and punctiliously used.

This zeal for maintaining gradations in rank extends even to the circles of the in-laws. One professor's wife who found she must curtail her visiting list did it by cutting off every woman attached to a man whose rank was less than that of a full professor, thus sparing her judgment the effort of evaluating the women, since the university had already carefully graded the men whose family interests they shared. And in two of our middle-western universities we are assured it is considered bad form for the wife of a man of lesser rank to pay the first call on the wife of a man of higher rank! We are not yet informed as to whether the distinctions are so carefully maintained by the children, servants, cats and dogs of the various families or not.

The distinctions one class cherishes seem merely absurd to people in other professions. We venture to say that no blacksmith, for instance, could fully appreciate these subtle discriminations in vogue in academic circles; and we academics, in turn, would probably rate blacksmiths rather much on a par. We might prefer one blacksmith to another, might think one had a stronger right arm than another, or even a stronger mentality; but if some of us were getting up a June procession of blacksmiths we probably should not trouble to put differing numbers of stripes on their sleeves, nor bother about adjusting the tassels on their

caps—if they could be prevailed upon to wear a thing so feminine—to make sure those of a certain grade of efficiency wore them hanging down into their right eyes, those of inferior grade into their left eyes.

Yet there lurks in the soul of at least one blacksmith this same craving for discrimination from his fellows that is so demoralizing a factor in academic circles. On Cottage Grove avenue in Chicago one may see his sign, "Fitzgerald"—the initials are gone from memory—"Fitzgerald, Professor of Horseshoeing." His shop is out toward the university; perhaps the infecting bacillus escaped from the confines of the gray stone walls. It is possible his motive for insisting on the distinction between himself and ordinary blacksmiths is merely a commercial one. But the bacillus for that disease might also have come from within the gray stone walls.

Two institutions for the perpetuation of this attitude of intellectual snobbery among even the elect are the honorary societies of Phi Beta Kappa and Sigma Xi. The former depends for its membership in most universities and colleges on the students who outstrip their fellows in grade getting. Any one who has been through one of our higher institutions of learning appreciates the ability this connotes—ability to memorize the lesson daily assigned, sensitiveness to idiosyncrasies in the instructor, so that in examinations one may return exactly the sort of replies the instructor expects, with warm appreciation of what has evidently been the teacher's hobby.

Sigma Xi, the honorary scientific society, prides itself on admitting to membership only those who have shown ability in some field of original research. Supposing for the instant that no Sigma Xi group estimates candidates by any lesser standard, one is still left wondering how long we are to consider this childish prize-offering necessary to faithful truth-seeking. It is appalling to note the pages of honors and prizes listed in many university catalogues. President Jordan makes this interesting comment: "Prizes, honors, badges and degrees,—all these have no necessary place in the machinery of higher education. If our universities had grown up in response to the needs of the people, not in imitation of the colleges of England, we should never have been vexed by these things, and never felt any need of them."

The newly rich blatantly announces his superiority over his fellows by his flaming necktie, flowery vest, heavy motor; with the academic these signs give way to the less blatant but no less effective Phi Beta Kappa or Sigma Xi key dangling on fob or necklace.

As has been repeatedly pointed out by other writers, our universities are based on autocratic rather than democratic organization, with the executive forces, of course, dominant. Now the executive mind inclines much more toward order than toward flexibility; it wants things definitely discriminated from each other, so must have definite rankings for students and faculty. It goes on with its efforts to tabulate mental

ability, preferring in all too many cases to sacrifice the unusual to the usual, the individual variation to the norm, rather than to let its careful gradations of rank be disturbed. The effort is to reduce to mechanical terms what is organic.

And because our universities must have tangible standards in tabulating members of the faculty, they have come to judge a man's worth by the number of pages of printed matter per year issuing from his pen rather than by the number of ideas issuing from his brain; by his reputation and consequent value in swelling university enrolment totals; by the number of his degrees—as though it were not difficult enough to get at the genuine worth of a man without having to excavate beneath title upon title and degree upon degree in the university catalogue, or without being distracted by his ability to display a new style hood for every Commencement procession.

The effects of this furor for tabulation are no less unfortunate on students than on faculty; the marking system with its emphasis on memory work and on appearing well in the eyes of another man, the rigidity of requirements for entrance and for graduation, and all those attendant evils best described as a tendency toward uniformity rather than individualization in our whole educational system,—these may all be traced to this zeal for standardization.

As a half-way house between students and faculty stands the Ph.D. degree. To the student it marks the culmination of his effort, and in some universities its attainment is a prerequisite to eligibility to membership on the faculty. Only men of unmistakably intellectual tastes—whatever that may mean—of originality, actuated by a love of truth and its pursuit, and believing such pursuit in itself a sufficient reward,—only such, presumably, are permitted the ordeal of the third degree.

Yet in its influence on students and faculty alike, much that this degree stands for is pernicious, and its acquirement is beset with evils. In these days a student soon sees the commercial value of a degree and is likely to come to his future work with hope of winning honor for himself rather than with the desire to do well some piece of work and to contribute to the world's knowledge. When he sees how difficult it is for a man to obtain opportunity to work in a university unless he can write those three magic letters after his name; when he sees, as sometimes happens, a man admittedly successful as a teacher and scholar dropped by a university because he lacks those three letters, the student is quite likely to submit to the system and take the degree, though he may be keenly conscious that half the time spent in so doing he could have used to better advantage. His work is interrupted; his ideal shifts from work for the joy of finding new truth to the temporary memorizing of useless facts, always with an eye to the questions each of his examiners is likely to ask. Instead of reviewing to get a large grasp of

a subject, he usually has in mind, "Such and such a thing is M.'s hobby; I'll cram on that"; or, "S. has been reading up on this subject the past few weeks; he will ask something about that."

Individual investigation is supposed to be a prerequisite to the obtaining of the Ph.D. degree; but the pressure for productive results from the faculty has become so strong on the part of the executive department, and competition for recognition so keen among instructors, that in, we venture to say, a majority of cases this individual and original problem required of the candidate for the Ph.D degree is one laid on him by his instructor, and is often merely a portion of a large piece of investigation the instructor parcels out year after year to his various students. In many cases the instructor is the only one who has a grasp on the larger problem, who understands it in entirety. The result of this practise is that the student is drilled as a technician rather than as an original investigator. He fails to see new problems for himself, and frequently leaves the laboratory in which he has worked as a student without the lure of problems ahead to be worked out. In the midst of all our agitation for conservation, we may be forgetting to conserve our greatest resource—power to do creative work of great originality, and this in the making of young Ph.D.'s, where we flatter ourselves we have best preserved it.

Instead of keeping such an ideal alive, too many of our so-called intellectual leaders have been caught by such childish and tawdry symbols as tassels, stripes, capital letters and the sight of their names in print. They have come to prefer honor from their fellows to self-approval.

This has led them not only to strive for reputation themselves, but to give credence only to the man who speaks authoritatively and from the heights of renown. Their acceptance of a new idea too often depends on the prestige of the man who has uttered it.

Prostitution of talent and character, the development of an intellectual aristocracy in a democratic land, an absurd clamoring for petty honors, increasing gaps and misunderstandings between classes and professions, dogmatism, commercialism, the inculcation of false ideals in young students, dependence on reputation rather than on genuine worth, emphasis on standardization rather than individualization in education, the effort to serve two masters—truth and the man immediately above one in rank, be he teacher, department head or president—all these are evils attendant upon our present system of academic honors and badges.

In contrast to these conditions, hear the ideal of William James:

> Our universities at least should never cease to regard themselves as the jealous custodians of personal and spiritual spontaneity.... They ought to guard against contributing to the increase of officialism and snobbery and insincerity as against a pestilence; they ought to keep truth and disinterested labor always in the foreground, treat degrees as secondary incidents, and in season and out of season make it plain that what they live for is to help men's souls, not to decorate their persons with diplomas.

THE FREQUENCY OF DREAMS

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IS there any dreamless sleep? I venture the assertion that probably all persons dream all the time when they are asleep (and sometimes when they are awake). There is perhaps no dreamless sleep.

Since authorities are about equally divided on this mooted question, it is necessary that a brief summary should be made of the grounds upon which our assertion rests. Such grounds may be seen in four directions: the observation that inability to recall a dream is no proof of the non-existence of the dream, certain theoretical considerations, experimental proof, and spontaneous expression of dreams. Many other lines of evidence might also be brought to bear. The proof must necessarily be inductive, and therefore can be only cumulative; the most that we can prove is a high degree of probability of the truth of the proposition.

The notion that dream-consciousness is not continuous in sleep rests essentially upon the memory test, the feeling that, since we recall dreams only occasionally, we have had only occasional dreams. We must therefore first examine that proof.

Replies to questions as to the frequency of dreams run somewhat like this: "Very much every night"; "Nearly every night"; "A dozen times a month"; "Hardly ever"; "Never." But such reports tell us nothing about the frequency of dreaming, for they refer only to the frequency with which dreams are remembered; and we know now that normally dreams are not remembered. Only the exceptional dream is remembered. If one has had a hundred dreams during the night, he may or may not remember one or more of them. Whether or not a dream shall be remembered depends upon its coherence, the strength of associational ties, the depth of sleep, the habit of recalling dreams, and many other similar conditions. As a rule, dreams are not remembered; mental development and efficiency in waking life are conditioned upon our freedom from the burden of consciousness of the massive apparent chaos of dream life.

We remember only those experiences which are coherent, clear, and rational—experiences that are more or less individualized and have meaning with reference to waking life. The vast mass of dreams are too fragmentary, too fleeting, too much thrust upon us as an undifferentiated jumble—in short, too meaningless to be remembered. Of the dreams which have meaning, we remember only those which are recent,

primary and strong, and stand in striking congruity or incongruity with our dominant feelings. Most of the coherent dreams are wanting in these respects and are only distantly relevant to waking consciousness. Of the relevant and coherent dreams, we recall only those for which situations in waking life chance to occur in such a way as to establish bonds of association that shall extricate them from the mass of unrecognized dream traces. You wake up in the morning after a sound sleep and may not be able to recall any dream; but the moment you stoop to lace your shoe a vivid dream image flashes up and you recall that you dreamed in the night of walking barefooted in the snow. Had there been no awareness of the shoe, this dream of the want of a shoe might not have been remembered. On the whole, there is a slight chance that situations in waking life shall so occur as to elicit the image of a dream which is sufficiently recent.

Even with all other considerations favorable, the ability to remember a dream is conditioned upon the presence of a habit of recalling dreams. The development of such a habit is on the whole undesirable; should a person remember all his dreams, he would lose his mind and be helpless; therefore the principle of natural selection tends to suppress dreams. The writer, like many other students of dreams, has found it advisable to abandon the intensive study of dreams because habits of observing and recalling dreams interfered with normal sleep.

The dreams which we remember come from light or disturbed sleep. The failure to remember dreams is roughly proportional to the depth of sleep. Sleep-walking, *e. g.*, occurs only in deep sleep.

Many apparently fabulous stories of feats in sleep-walking are found true. A college student formed the habit of getting up in sleep, dressing, walking down to the Mississippi River, three quarters of a mile distant, undressing, taking a deliberate and enjoyable swim, dressing, walking back to his room, undressing, and retiring, only to wake up in the morning without the slightest inkling of remembrance from the escapade of the night. But when his friends constituted themselves detectives and awakened him suddenly in the act, the whole performance stood out clear to him in his memory. Sleep-walking is dream-action. If a sleep-walker is allowed to return to bed without being awakened, he will have no memory of the dream action in the morning.

In deep sleep we may do anything we could do in waking life, and even more, for the dreamer may become a distinct second personality, free from some of the limitations of the waking personality. Thus we have in dream action evidences of the most amazing complexity in the deepest undercurrents of mental life, under the very conditions which preclude the possibility of memory of the dream.

In view of such considerations, it is clear that from the negative point of view, arguments for dreamless sleep on the basis of the memory test can have no valid foundation.

Turning then to our theoretical proof, we find a strong argument in the generally recognized correlation of mental activity with certain neural activities. There are many theories of this relationship, but for the present purpose we need not assume that this correlation is complete, nor need we inquire into the nature of the causal relations; the fact that there is an observable correspondence is enough. We know from physiology that no part of the nervous system is ever wholly at rest. With the exception of the eye, all the senses are open in sleep; taste, temperature, and tactual stimuli are often conspicuously present in sleep. It is difficult to conceive of any condition in which this flux of sense impressions, should be absent. All these sense impressions in sleep cause dreams, and the central association mechanism is constantly at work weaving an intricate network of relationships among these impressions thereby giving them meaning, however far-fetched. Indeed, the very closing of the eye as in sleep is conducive to an increased play of visual impressions, for the internal stimulation gives rise to the so-called retinal light, which may be very brilliant, and is always seen in a more or less gorgeous kaleidoscopic motion. It has been well called the stuff that dreams are made of.

Stimuli through ear, nose, skin, muscle, and even the closed eye, affect the mental organism on the same principle as in waking life. Internal stimuli act not only upon the sense organs, but also directly upon the brain and other nerve centers. Pressure caused by the rush of blood, metabolism, and other mechanical stimuli arouse nerve impulses. Probably chemical, thermal and electrical action within the body tissue may stimulate nerve elements directly. Theoretically such centrally aroused nerve impulses have their mental correlates. On the theory of concomitance, we must therefore assume that there is a continuous stream of mental processes which correspond more or less to the continuous activity of the nervous system. In sleep such mental processes are, of course, subliminal: they are dreams.

In short, on the theory of correspondence between certain mental and neutral processes, the continuous impressionability of the senses and the constant stimulation within the central system itself point to an uninterrupted dream activity in sleep.

Experimental procedure has brought direct proof which is cumulative and has revealed no exceptions. Proceeding on the assumption that a given sense stimulation will cause a particular dream, Alfred Maury many years ago made experiments of which the following are typical:

First Experiment.—He caused himself to be tickled with a feather on the lips and inside of the nostrils. He dreamed that he was subjected to a horrible punishment. A mask of pitch was applied to his face, and then roughly torn off, taking with it the skin of his lips, nose and face.

Second Experiment.—A pair of tweezers was held at a little distance from his ear, and struck with a pair of scissors. He dreamed that he heard the ringing of bells; this was soon converted into the tocsin and this suggested the days of June, 1848.

Third Experiment.—A bottle of eau de Cologne was held to his nose. He dreamed that he was in a perfumer's shop. This excited visions of the East, and he dreamed that he was in Cairo in the shop of Jean Marie Farina. Many surprising adventures occurred to him there, the details of which were forgotten.

Fourth Experiment.—A burning lucifer match was held close to his nostrils. He dreamed that he was at sea (the wind was blowing in through the window), and that the magazine of the vessel blew up.

Fifth Experiment.—He was slightly pinched on the nape of the neck. He dreamed that a blister was applied, and this recalled the memory of a physician who had treated him in infancy.

Sixth Experiment.—A piece of red-hot iron was held close enough to him to communicate a slight sensation of heat. He dreamed that robbers had got into the house, and were forcing the inmates, by putting their feet to the fire, to reveal where their money was.

Seventh Experiment.—The word Leonore was spoken. On awaking, he recollected this word, and found that he had attributed it to one of the persons who had conversed with him in his dream.

Eighth Experiment.—A drop of water was allowed to fall on his forehead. He dreamed that he was in Italy, that he was very warm, and that he was drinking the wine of Orvieto.

Ninth Experiment.—A light, surrounded with a piece of red paper, was repeatedly placed before his eyes. He dreamed of a tempest and lightning, which suggested the remembrance of a storm he had encountered in the English Channel in going from Merlaix to Havre.

In each of these experiments the dream could be reproduced because the dreamer was awakened in the very act. Had he been allowed to sleep until morning, there would have been but little likelihood of the recalling of the dream. The significant fact is that, allowing for the realism and the dramatic form of the dreams, experimental procedure confirms the theory that every sense impression tends to produce a corresponding dream. And, as we have noted above, the senses are all responsive in sleep, there is no silence, no darkness, no freedom from the impressions of odor, taste, touch, strain or temperature. This continuous stimulation of the senses results in a continuous flux of dream flashes, many of which lead to extended dreams.

The probability of dreams from a given set of stimuli is increased beyond that of analogous situations in waking life by the fact that the dream is not a true representation of the stimulus, as the waking impression is supposed to be. When awake, you may merely note a slight taste of bitter in the mouth; whereas, in the dream, the same condition on the tongue might make you dream of going through some awfully bitter experience, of being poisoned, or of eating some disagreeable substance with distressing consequences.

It is possible to enter into conversation with a sleeping person; and,

if the sleeper is not awakened at the time, he is not likely to remember anything about it. The replies are proof that the apparently dreamless sleeper hears the conversation, understands it, and fits his words to the ideas in mind. It is claimed that talking to a sleeping person is an effective way of instilling ideas which it is desired should work themselves out in the waking state. The method has been employed in the breaking up of bad habits and in the effort to create desirable habits.

Hypnosis may be employed to bring out evidence of dreams from apparently dreamless sleep. If a person wakes up after an apparently dreamless sleep, he may be hypnotized and given the suggestion to recall dreams from that sleep. There is such a kinship between the dream state and the hypnotic state that it is quite possible to conjure up in the latter the experiences of the former. The report of such dreams may be checked and verified, in part at least, by controlling conditions for production of dreams experimentally in the sleep, and then checking up the hypnotic report by these known causes of dreams.

Waking suggestion may be employed, some think, even more effectively. By Freud's method of psychoanalysis the dreamer is put through a sort of sweat-box process, not necessarily unpleasant, in which the inquisitor, by following clues progressively revealed, discovers stimuli which step by step lead to the effective associations that may recall to memory dreams not otherwise recallable.

A most interesting extension of the field of dream interpretation has developed in recent practice of psychoanalysis. If the patient is unable to recall any dream, the physician asks him to invent one, and it is found that such an imaginary dream partakes of the nature of a real dream; *i. e.*, cause and effect may be traced and it may be "interpreted" as if it had been a real dream.

The experimental evidence, then, tends to prove that dreams are caused by natural stimuli as sensations are caused in waking life: given a sense stimulus, we may expect a dream to follow. The fact that a dreamer may carry on a dream conversation, or influence the formation of habits by suggestion in sleep, is proof of highly complex and rationalized activity in sleep, of which the dream carries no trace into waking consciousness. The experiments with hypnotic suggestion and waking suggestion add convincing evidence to the belief that, whenever we have adequate means for the testing of a given moment of sleep, we find it occupied with dreams.

The theoretical conviction thus strengthened by experimental tests is further fortified by close observation of spontaneous expressions of dreams. It is a law of psychology that what is in the mind tends to express itself in appropriate action, even though only inceptive and normally only faint. A skilled observer watching a sleeping person may be able to observe uninterrupted evidence not only of a continuous

stream of dreams, but also of rich complexes of dream conflicts. If this observation be done with the expert skill of a so-called mind reader, most marvelous reports may be drawn from dream-life through the unconscious reactions, especially the rich play of facial expression, which is eloquent language. The observer also "reads" the environment with the same skill and, by associating the continuous flow of sense stimuli with the psychophysical expression, his observations are reduced almost to experimental control.

It may be said that these contentions prove too much in that they prove the presence of dream consciousness in the waking state. That is granted, and it is an important fact. We dream a great deal on the ordinary rounds of duty. One who is trained in psychological observation of dreams will catch himself frequently in moments of dream-consciousness, sometimes infinitesimally short and in the midst of mental application. On opening a Christmas package, *e. g.*, skilful retrospect would probably reveal to him glimpses of himself in childhood scenes and he might notice that in spite of the self-conscious and joyous activity of the moment, a sort of other self, split off from the waking self, joined these momentarily merging flashes from dream-life into continuity. The writer has observed dream flashes in his own mind, even while lecturing before a large audience. More significant, however, is the presence of that broad stream of subconscious impressions which underlies waking consciousness but passes unobserved. These subconscious impressions in waking hours have much in common with dreams.

The theory of dreamless sleep came into vogue at a time when man held a crude and all too simple view of the mind. Experimental psychology has deepened insight and broadened our view of mental life, ever revealing more and more aspects before unobserved. Only a few years ago, it was thought that to have an illusion or an hallucination was of necessity to show mental weakness. Hallucinations and illusions were therefore supposed to be rare objects of curiosity. Now we know that hallucinations and illusions are normal and ever present in all well-regulated mental life. It has been shown that the conditions which cause illusions and hallucinations are as a rule fundamental and essential conditions of normal mental power. The very principle which enables us to see true perspective in one situation leads of necessity to illusion in many other situations. Now, the man who asserts that his friend has been subject to an illusion, as if he himself were exempt, is the man who asserts that he dreams only occasionally. It may be safely maintained that the authorities who defend the theory of dreamless sleep espoused this theory before the recent notable advances in our scientific knowledge in psychology of cognition were made. The more we study dream life in the light of scientific method in psy-

chology, the more the idea of the ever presence of the dream in sleep grows upon us, not as a result of more and more observed cases only, but rather as a logical inference from growing knowledge of the operation of mental law.

The arguments advanced in support of the continuity of dream life imply and lead to certain interpretations of the nature of the dream, which give it a true setting in an evolutionary and naturalistic conception of the mind and give us a deeper insight into the actual richness and significance of dream life.

Conscious memory follows only a very small part of our waking experience. No one can recall more than an infinitesimal part of the images and ideas which flit through his mind in a day. Watch the flow of free association in your own mind for ten seconds. The display of ideas and images in their rough-and-tumble struggle for recognition is so rich and rapid that no one can speak fast enough to name them as they pass upon the arena of consciousness. Such a display goes on in a subliminal way, while consciousness is directed elsewhere. There is in all our conscious life a rich encircling fringe of this free association, but we have acquired some power in keeping this "fleeting show" subliminal because that is conducive to sanity and mental efficiency. A student asked to observe it for the first time tends to perceive but little following, this habit of suppression; but soon he finds himself in the position of one who, at a glance, notices but a few stars and attempts to count them; the more he tries to count, the more the field of vision tends to fill up with the countless.

The more absent-minded we are, the more coherent and prolonged these free associations become. The step from absent-mindedness to light sleep is in the same direction and is no larger than the step from active attention to absent-mindedness. These free associations constitute our dreams. Free from the limitations which operate in waking life, free even from the bounds of waking imagination, free association holds full sway and winged fantasy is at her best. Dream fantasy has moving pictures outdone, for the prevailing dream type is that of the flash-picture or snap-shot, and sleep affords the best condition for richness of setting and rapid change of scene. How little of this rich dream life we actually remember may be realized if we consider that a dream which in the recall may be represented as lasting an hour may be but the conscious elaboration of what in the actual dream was merely an instantaneous flash image.

The theoretical considerations discussed above are also replete with implications in regard to the nature and meaning of dreams. The dreamer is *en rapport* with the environment, for dream consciousness is responsive to the play of the senses, and dream apperception, representing all past experiences, takes in, modifies, interprets and responds

to impressions, weaving them into the web of dream personality. If then it is true that dream life is a part of the same substratum of mental activity that underlies waking consciousness, it follows that the dream impressions and the dream elaboration continually modify mental content just as the subliminal impressions of waking life do, but, except for the operation of the principle of recency, with vastly greater variety of impressions and effectiveness of result.

Experimental procedure in the production and observation of dreams also enriches our concept of dream nature in that it enables us to set crucial tests and observe details which may serve as a basis of generalization. It not only helps to convince us of the continuity, but reveals and confirms the operation of natural law, so that we realize that, although the dream operates in flagrant violation of the principles of time, space, reality, and cause and effect according to the standards of waking consciousness, it nevertheless flows in accordance with natural law in every respect and at every stage. Every dream fantasy—even every dream fragment or flitting image—occurs in accordance with the principle of cause and effect and is a phenomenon in mental nature just as truly as a blade of grass is a phenomenon of organic physical nature. From this point of view the dream is a chaos only in the same sense that the masses of stars are a chaos. Both are organized, the stars a macrocosm, the dream a microcosm.

With the point of view developed, after exclusion of irrelevant evidence and the acceptance of theoretical and experimental evidence in support of the continuity of dream-life, we are prepared to read meaning into the expression of dreams. The fact that our twitchings, inceptive speech movements, and even sleep walking occur as an expression of the dream is insignificant in comparison with the related fact that the dream expresses itself in our waking life. It not only modifies dispositions which result in feelings, attitudes, moods and impulses that characterize our waking consciousness, but often a specific dream determines our opinion, emotion, memory or decision in the same way as if the dream experience had been an actual waking experience. This is quite as true for the dream that is never remembered as for the dream that is recalled, and, as a rule, we are not aware of the source of such influence.

THE SIGNIFICANCE OF VENOMS

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"A WEED," said Webster, "is a plant for which we have found no use." To be exact he should have added: "except in medicine"; for the oldest, and, until recently, the most empirical of the sciences has been the dumping ground for all products both plant and animal which had no other possible use.

In no case has this process been more persistent than with those products which have a marked physiological effect. It is to this persistent experimentation that we owe nearly all of the drugs of modern medicine. The venom of poisonous snakes has not been exempt, despite its great virulency. The facts that it retains its power when dried and powdered and that it is wonderfully uniform, and thus lends itself to a sort of standardization, have made it subject to no little exploitation. Had this exploitation been started twenty years earlier in the history of medicine, doubtless we should now have many records of "cures" resulting from its use. It came, however, at a time when the medical man had learned to be wary of new drugs, except those whose physiologic usefulness could be demonstrated.

Snake venoms from the other side of the therapeutic shield, that is, as agents to be combated rather than as medical ammunition, still hold interest to the point of fascination. In America this interest is disproportionate to the importance of its subject. In many regions all snakes, beneficial ones as well as venomous ones, have been exterminated, practically at least. It is true that along the southern Atlantic and Gulf coastal plains, the danger to man from the ever-present and vicious moccasin (*Ancistrodom piscivorus*) is a factor of some importance; and, in the southern part of the Rocky Mountain region, the western diamond-back rattler (*Crotalus atrox*) probably will not be exterminated for several decades. Elsewhere danger from snake bite is almost negligible.

Lest the statement in the last paragraph bring on my head a storm of protest, I shall mention a fact known to all naturalists; and that is that most snake bites are from non-venomous snakes. The colubers of the middle west are very belligerent serpents, and attack with satanic fury. Because of the hazel brown markings any member of this group is popularly branded as a "copperhead," a name which properly belongs to *Ancistrodon contortix,* a truly venomous reptile, but a small snake and

seldom or never found in plowed fields where the colubers go in their search for rodents. The region inhabited by the deadly moccasin is also frequented by enormous numbers of the red-bellied water snake (*Tropidonotus taxispilotus*) which is almost always called a "moccasin." The bite of this snake is harmless, aside from the actual mechanical injury, which may be considerable. Ditmars says of it: "It is in disposition one of the most ugly of American snakes." This is a mild statement. It is the experience of the writer that this water snake is the most depravedly vicious of all wild animals.

Do not these and other cases of errors in classification account for the success of some of the bizarre treatments which have been reported, some of them, to be frank, by even high-class medical men?

Venomous snakes have long been grouped according to the action of their venom. One extreme is represented by the rattlesnakes, whose venom is powerfully hemolytic, and acts on and through the circulatory system. The other extreme is represented by the cobras, asps, etc., whose venom acts much more rapidly and affects the nervous system directly. Noguchi refers to the two types of venom as "hemotoxic" and "neurotoxic."

Of more than passing interest is the fact that the tiny coral snake (*Elaps fulvius*) which is found in decaying logs and similar places in this country, carries a venom which is, as several workers have shown, qualitatively closely similar to that of the deadly cobra. But its sluggish and retiring disposition together with its small size make it inconsequential.

The moccasin and the copperhead, both members of the genus *Ancistrodon,* have a venom which seems to contain a little of the neurotoxic element, but its principal effect is much like that of the rattlesnakes.

There are, furthermore, a few small mildly poisonous snakes in America known to naturalists as Opisthoglyphs, because their fangs are grooved instead of tubular.

Despite the fact that the rattlesnakes contain two genera and a large number of species and vary greatly in color and general appearance, the natural history of American poisonous snakes is quite simple. The moccasin and the copperhead have exactly the same markings; but the former is very much darker in color, the pattern sometimes almost obscured.

Our *dangerous* snakes, then, may be said to be: First, those bearing a rattle; second, those having a series of dark brown hour-glass-shaped markings on a lighter brown background.

A further consideration to be borne in mind is that the venom of all of these is of the deoxidizing hemolytic type; and the standard potassium permanganate treatment has never been improved upon. The

Calmette anti-venomous serum widely advertised and sold by sporting-goods houses, while extremely useful against the effects of Oriental snakes, is useless in America. A limited quantity of anti-crotalus serum is put out by the Rockefeller Institution, but under experimental conditions this is said to be of rather doubtful value because of the large amount which must be used.

For some years the writer has carried on, intermittently, some investigations in connection with popular beliefs regarding the slightly venomous properties of certain snakes not generally considered poisonous by zoologists. The persistence of some of the rumors, and their confirmation in a few cases by medical men, gave him the idea that the presence or absence of the poison mechanism, grooved or tubular fangs and well-developed poison sac, may not always serve as a criterion of the reptile's potential venomousness. Unknown to the writer others, Alcock and Rogers, were carrying on similar investigations. No final results have yet been published; but the writer, at least, has been able in some cases not only to demonstrate the presence of a real toxic element, but actually to formulate quantitative terms.

Of course a snake which has not developed the proper poison mechanism for injecting its venom is not very dangerous, even if its saliva is quite toxic.

Weir Mitchell established many years ago a fact that had long been suspected: that the poison gland of a venomous snake is identical with the parotid salivary gland of mammals. Noguchi in his monumental work on snake venoms[1] has pointed out that this structure goes through quite an evolutionary series. To be brief: in the amphibia and certain reptiles, this gland is a pure mucous gland; and in the higher mammals it is a pure serous gland. In the poisonous snakes it is almost half mucous and half serous. The relatively high development as to size is undoubtedly a secondary adaptation to take advantage of the poisonous naturè of the secretion.

The writer believes that in time it will be demonstrated that the transition, beginning with a simple recurved tooth, followed by the immobile grooved fang, and ending with the highly developed tubular and erectile fang, is also secondary and follows the development of the poison gland.

Furthermore, it would seem that the development of the neurotoxic element is also secondarily developed. Noguchi has shown that the division of snake venoms into hemotoxic and neurotoxic is a convenient, but arbitrary, arrangement. It seems that the fundamental substance is something of a hemolytic nature, always present, whose relatively slow action may be covered up by the neurotoxic element when the latter is present.

[1] Pub. 111, Carnegie Institution.

The old macroscopic distinction between serous glands and mucous glands is that serous glands are those whose membranous surfaces are closed to the outer air (the lining of the blood vessels, the pleura, and the peritoneum); mucous glands are those whose membranous surfaces are exposed at some point to the outer air (the lining of the alimentary canal, the lining of the genito-urinary machinery, etc.). Of course, there are important histological differences also. With this distinction in mind, the comparative anatomy of the parotid gland is more than suggestive of the mode of origin of the venom of snakes. The writer believes that the toxic quality is due to a surplus quantity of deoxidizing or correcting element.

Transitions occur in the venomousness of salivary secretions. Besides the cases referred to, Alcock and Rogers showed that the parotid secretion of *Zamenis mucosus*, one of the blacksnake tribe and usually considered a harmless snake, is distinctly toxic and a moderate dose is enough to kill small mammals. The writer has confirmed this in other species of *Zamenis* and certain other snakes. It is a rather striking fact, however, that the saliva of coluber and tropidonotus appears to be not in the least poisonous.

As to transition forms above the snakes, certain small mammals are at present under suspicion; particularly the small black skunk (*Mephitis mesomelas*), the alleged "hydrophobia skunk," often incorrectly called the civet cat.

It is more than likely that certain small mammals which, in various parts of the United States, are popularly thought to be "reservoirs" of hydrophobia, owe their reputation to a hemolytic element in their salivary secretions. The symptoms resulting from the bite of such an animal are exactly what an uninitiated person expects in hydrophobia. In fact the symptoms are much more in accord with the popular conception of hydrophobia than is genuine rabies itself. This is aside from the long period of incubation which rabies requires, and which is often overlooked.

PROBLEMS ASSOCIATED WITH THE STUDY OF CORAL REEFS. II

By Professor W. M. DAVIS

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The Theory of Submerged Platforms.—A modification of the theory that explains barrier reefs as veneers upon wave-cut platforms has been lately and briefly proposed. It regards the lagoon floors as platforms that were produced, while the central island stood higher than now, by some planation process or processes other than those concerned in the production of coral reefs, and then explains the reefs as veneers formed on or near the edge of the platform as it is submerged to its present depth. This theory has the merit of accounting for the embayed shorelines of the central island, inasmuch as the valleys which must have been eroded in it during the planation of the platform while the island stood higher, must have been partly drowned when the platform was submerged; but the theory has the demerits of tacitly postulating the absence of reef-building corals while the platform was being produced, and of leaving the processes by which the platform was produced unspecified. It would be easy to account for the platforms by subaerial planation, if the area that they occupy had consisted of weak rocks in comparison to those of the still mountainous central island, but there is not the least evidence that such was the case. Again, it would be easy to account for the platforms by marine abrasion, if corals were absent; but in that case the central island ought to be rimmed around by cliffs, as in the preceding theory. It is unreasonable to assume that corals were absent; for they have long been present in the coral seas, as is shown by the existence of uplifted and dissected reefs, having embayed shorelines and enclosed by barrier reefs such as the present theory seeks to explain. Moreover the form of the embayments on a good number of islands indicates that the depth of their submergence is decidedly greater than the depth of the lagoon upon which they open, as will be further shown when the glacial-control theory is discussed on a later page. The fact that certain barrier reefs are discontinuous and not always on the outer edge of the platform represented by the lagoon floor has been taken in support of this theory and as indicating that the platform has been produced by other agencies than those which produce reefs; but discontinuity of reefs and their displacement from the platform edge can be well explained by other theories alsc, such as the theory of subsidence, if it be assumed that subsi-

dence proceeds at different rates, now faster, now slower. If the fuller statement of the submerged platform theory, yet to be published, gives good ground for the absence of corals while the platforms were in the making, and reasonable explanation of the manner in which the platforms were made, it would have a better prospect of acceptance.

Darwin's Theory of Subsidence.—Let us now consider the theory formerly so popular, the theory of coral reefs which most of us learned at school or college, but which later came to be regarded by many able geologists as "no longer generally applicable." This theory supposes that the oceanic island or continental border on which a fringing reef is established intermittently subsides while the reef slowly grows upward: thus the fringing reef is transformed into a barrier reef around the diminishing central island, while the coral waste washed over the reef and the land waste washed down from the adjoining land surface, together with organic deposits formed in the lagoon itself, nearly fill the lagoon with horizontal strata; and later, when subsidence has gone so far that the central island has disappeared, the upgrowing barrier reef encloses an uninterrupted lagoon and is called an atoll. Here the associated problem takes on a new form. It is now necessary to work out the changes suffered by an island that is slowly submerged while its sur-

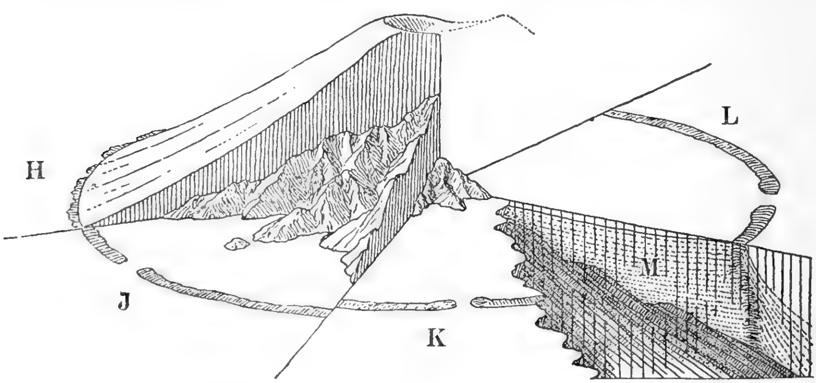

FIG. 13. DIAGRAM OF SUCCESSIVE SECTORS OF REEF FORMATION, as deduced from Darwin's theory of upgrowing reefs on subsiding islands.

face is eroded and a reef grows up around it. As before we begin in sector *H,* Fig. 13, with a large volcanic island, built up by frequent eruptions from the ocean bottom to some thousands of feet above the ocean surface. In due time a narrow fringing reef is established around its shores, interrupted at stream mouths where much detritus is washed down from the sharp-cut young valleys. Subsidence may have been going on slowly while eruptive upbuilding was going on more rapidly; now eruption has ceased, but subsidence is assumed to continue. What will be its effects? The effects of elaborate dissection

and moderate subsidence are shown in sector J; the effects of continued dissection and greater subsidence in sector K: and of complete submergence in sector L. This may be illustrated in another manner: During the progressive changes caused by erosion and subsidence, the simple initial shoreline of the central island consequent on eruption, shown in the background block of Fig. 14, must be changed to an indented or embayed shoreline consequent on the partial submergence of a dissected cone, as shown in the middle section of the figure. Eventually the island sinks out of sight and the atoll reef grows up, enclosing the uninterrupted lagoon, as in the foreground of Fig. 14.

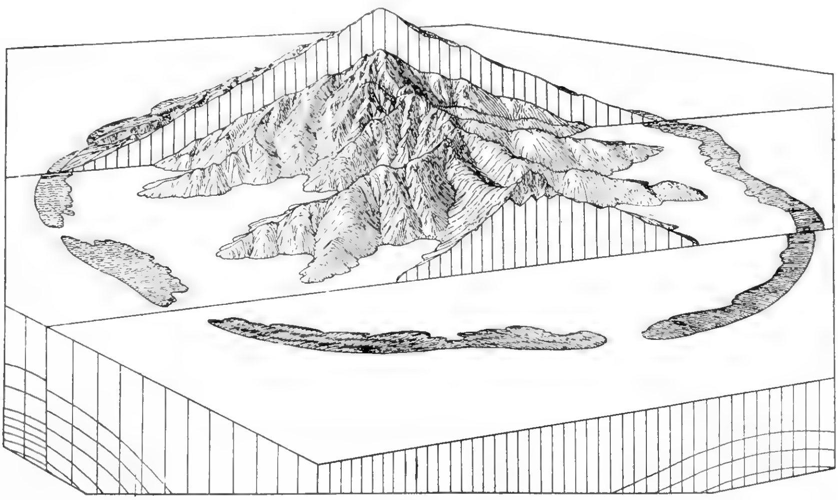

FIG. 14. BLOCK DIAGRAM OF A SUBSIDING VOLCANIC ISLAND IN AN OCEAN OF CONSTANT LEVEL. Background block, a high-standing island with a simple shore line bordered by a fringing reef; middle block, a partly submerged island with an embayed shore line and a barrier reef enclosing a lagoon; foreground block, an atoll reef around an uninterrupted lagoon over a vanished island.

The proportion of the several ingredients in the lagoon deposits will vary according to the size of the reef, the strength of the waves, the size of the island, and so on. The horizontal lagoon layers must rest unconformably on the eroded flanks of the subsiding volcano, as is shown in section M on the side of sector L, Fig. 13. Outside of the reef there should be a long, sloping talus, largely composed of coral fragments, except that opposite each pass or break in the reef, where the great volume of sea water that surges in over the reef-flat must find its escape, there should be a significant outwash of fine volcanic waste so long as the lagoon is of moderate width; for the lost volume of the initial volcano can not be represented only by the near-shore intermixture of volcanic detritus with the calcareous lagoon beds. The lower ends of the slanting layers of exterior talus thus formed must lie on the submarine constructional slope of the volcanic cone.

Two of these consequences deserve more emphasis. First, it must be understood that production of an indented shoreline, as in Fig. 15, by the subsidence of a dissected island is not a vague speculation; it is a geometrical necessity of the same order as that which defines the pattern of the conic sections; for the intersection of a fluted cone by the level surface of the sea must be an indented line. Second, if the subsidence is accelerated, the reefs may be incompletely built up to the

Fig. 15. The Embayed Shore Line at the Northwest End of the Partly Submerged Island of New Caledonia; the water is part of the large lagoon enclosed by an extensive barrier reef. The farther shore line should be level.

surface, and appear only in narrow and discontinuous patches; or, if subsidence be over-rapid, the reef-building corals may be drowned by being submerged to too great a depth; if the subsidence is then retarded, a new fringing reef will be established on the submerged flanks of the island and will in time develop into a new barrier reef of smaller radius than before; in the early stage of the second reef the amount of subsidence indicated by the breadth of its lagoon will be much less than that indicated by the size of the embayments. But if it is an atoll that is thus drowned, it can not grow up until it is again uplifted nearer the surface or until it is built up to less depth by organisms other than reef-building corals. On the other hand, if subsidence ceases for a sufficient time, a barrier reef will widen by outward growth and inward over-wash, the deltas will be built forward and the lagoon will fill up; thus a broad, mature reef plain will, if the still-stand pause lasts long enough, more or less completely replace the narrow young reef and the lagoon. A brief and small elevation may occur at any stage, uplifting the reef a few feet out of water, when it will be attacked and dissected

by weather and waves, or submerged if subsidence sets in again. The reason that these consequences are so varied is evidently that subsidence is a much more variable process than standing still.

Success of Darwin's Theory.—Now how did this old theory fare? It gained immediate and universal acceptance. Was this because its author's experience was such as greatly to commend it? By no means; for Darwin was then a young naturalist, just returned from his first and only voyage of exploration. Did he consider other theories also? Yes, he did that most fairly and candidly; the theory of outgrowing reefs around still-standing islands, the theory of veneering reefs on wave-cut platforms, and several other theories were carefully examined, and critical reasons were stated for their rejection. Did the young naturalist deduce all the consequences of his theory, somewhat as above stated? No, not all; he stated several of them clearly enough, but he unfortunately made the serious error of overlooking one of the most essential consequences, namely the occurrence of embayed shorelines around the subsided central islands of barrier reefs; and thus failed to secure for this theory the confirmation that might have come from its success in explaining certain things that it was not invented to explain, as well as all the things that it was invented to explain. Why, then, was his theory received with so great favor? Evidently because those who accepted it were not in the habit of demanding that a successful theory should do something more than explain the things that it was invented to explain, and because they were satisfied on finding that it provided a simple, easily conceived scheme for correlating and explaining the numerous and varied facts that it was made to explain. Was that not enough to establish it? It seems to have been enough, as long as the theory had no serious competitors; for it was not only universally accepted, but as late as 1882 was referred to by an eminent critic as "a theory which for simplicity and grandeur strikes every reader with astonishment. . . . No more admirable example of scientific method was ever given to the world." Darwin's exposition of his theory was certainly admirable, but it is going too far to say that a theory, from which the essential element of independent confirmation was lacking, is as admirable an example of scientific method as the world has seen.

Unwarranted Loss of Faith in Darwin's Theory.—Naturally enough, when another possible theory was put forward, a critic, who had no independent and crucial test in mind by which his belief in an earlier theory was compelled, lost his confidence in it, even though the later one had only the same insufficient recommendation of explaining what it was made to explain; for it was the same critic who, only a year after commending Darwin's theory of subsidence in the glowing terms just quoted, abandoned it and became the avowed champion of the theory of outgrowing reefs on still-standing islands. He may even then have

felt the keen regret expressed twenty years later "that this brilliant generalization of the great naturalist [Darwin] has been deprived of the wide application which for many years we attributed to it," for he wrote:

> In face of the evidence which has now been accumulated, I can no longer regard the . . . theory [of subsidence] as generally applicable. . . . No satisfactory proofs of a general subsidence have been obtained from the region of coral reefs, except from the structure of the reefs themselves, and this is an inference only, which is now disputed. From the nature of the case, indeed, traces of subsidence can hardly be expected.

True, the fact that the depth of certain barrier-reef lagoons had been found greater than 20 or 25 fathoms, the limiting depth for the growth of reef-building corals, was taken to indicate subsidence for those particular reefs, but not for other barrier reefs within which the lagoons were shallower.

Yet it is precisely a general proof of subsidence, at once simple and convincing, that had been independently discovered and published by an earlier and responsible investigator thirty years before, and that was completely overlooked by those who accepted the newer theories; namely, the occurrence of embayments in the central islands of barrier reefs, by which Dana had not merely given new support to, but had provided much-needed confirmation for Darwin's theory; and the most curious thing about the matter is that the eminent geologist, who, after he had abandoned Darwin's theory, championed the still-stand theory in the sentences just quoted, had himself, in an admirable book written nearly twenty years earlier, explicitly recognized the origin of embayments by submergence; for he then said:

> The sea lochs of the west coast [of Scotland] are thus not cut out by the waves, but old glens that have been submerged beneath the sea.

This is just as true for the numerous bays of the antipodal island of New Caledonia with its great barrier reefs as for the sea-lochs of Old Caledonia. In view of all this one must wish that the above-quoted champion of good work in all branches of geology would apply the elementary physiographic principle of shoreline development, not only to the drowned glens of Scotland, but also to the embayments of the reef-encircled Pacific islands where it is so clearly pertinent, and thereupon modify his conclusion that the theory of subsidence is no longer generally applicable in the explanation of coral reefs; for we may surely say of him what he said of an earlier student: The example of Darwin's own candor and overmastering love of truth remains to assure us that no one would have welcomed fresh discoveries [or, as we may interpolate, the resurrection of old discoveries] more heartily than he, even should they lead to the setting aside of his own work.

When the history of natural science is written, it will, I believe, come to be regarded as a curious commentary on the scientific methods of the nineteenth century, that choice among the various hypotheses invented for the explanation of coral reefs was guided so largely by personal habits of thought rather than by logical demonstration; for clearly enough the really successful one among all the proposed hypotheses can be detected only by its ability to survive a crucial test; that is, by its capacity to explain certain essential facts not in mind when it was invented and not explicable by any other hypothesis. A still more curious comment will be pronounced on the coral-reef chapter of scientific history, when it is learned that, as has been shown, a crucial test of the most admirably simple and convincing kind had been, as far as barrier reefs are concerned, discovered and announced a very few years after the publication of Darwin's theory of subsidence, but that it remained unnoticed for years thereafter. It never came to the attention of the author of the subsidence theory himself, perhaps because, as he wrote, "geologists do not read each other's books"; and it seems to have been altogether unknown to the inventors of the later alternative theories, who, had they been better informed, would have at once perceived that their inventions were incompetent.

Dana's Confirmation of Darwin's Theory.—From what has now been said, the nature of Dana's confirmation of Darwin's theory must be clear. The only obscure matter is: why was the clear confirmation so generally overlooked? Dana wrote in his report on the Geology of the United States Exploring Expedition, published in 1849:

> The very features of the land [of barrier-reef islands], the deep indentations, are sufficient evidence of subsidence to one who has studied the character of the Pacific islands.

Farther on in the same volume, under the general heading, "Evidence of Subsidence," and the special heading, "Deep Bay-indentations in Coasts as the Terminations of Valleys," he stated the case more fully as follows:

> In the remarks upon the valleys of the Pacific islands, it has been shown that they were in general formed by the waters of the land, unaided by the sea; that the sea tends only to level off the coast, or give it an even outline. When therefore we find the several valleys continued on beneath the sea, and their enclosing ridges standing out in long narrow points, there is reason to expect that the island has subsided after the formation of the valleys. For such an island as Tahiti could not subside even a few scores of feet without changing the even outline into one of deep coves or bays, the ridges projecting out to sea on every side. . . . The absence of such coves, on the contrary, is evidence that any subsidence which has taken place has been comparatively small in amount.

This explanation has been abundantly confirmed by later investigations; the principles that it involves are to-day everywhere accepted as

fundamental in the study of shorelines. The submergence of a mountainous coast must necessarily produce an embayed shoreline, with many out-stretching points of the land separating as many in-reaching arms of the sea. Bays thus produced are often called drowned valleys, in view of their origin. They are beautifully exemplified in many parts of the world far outside of the coral zone, as in the accompanying view of the Bay of Islands in northern New Zealand, Fig. 16. Simple as

FIG. 16. PART OF THE BAY OF ISLANDS, a half-submerged district in northern New Zealand.

the explanation of embayed shorelines by submergence is, it was first recognized by Dana in 1839 when he was on a mountain peak in Tahiti; he was indeed the first man in the whole world to perceive that valleys, half drowned by submergence, must form bays; and conversely that bays, which are continued downward from the non-drowned upper part of valleys, demonstrate submergence. But it was not alone that Dana gave this simple explanation of embayed coasts; he demonstrated further that embayments can not be the work of the sea, as seems to have been Darwin's idea, for Dana saw that the sea, unhindered by coral reefs in its attack upon a land margin, tends to simplify an indented coast line by cutting back its promontories, so that the complexity of outline seen in an alternation of lobate promontories and branching bays, interlocking with one another in intricate fashion when initiated by sub-

sidence, would be changed to a less irregularity of outline as the land heads were cut back in retreating cliffs, and the bay heads were filled up with advancing deltas; and that there would eventually be developed a marked simplicity of outline when the cliffs were cut farther back than the initial heads of the bays. Dana had good ground for his ex-

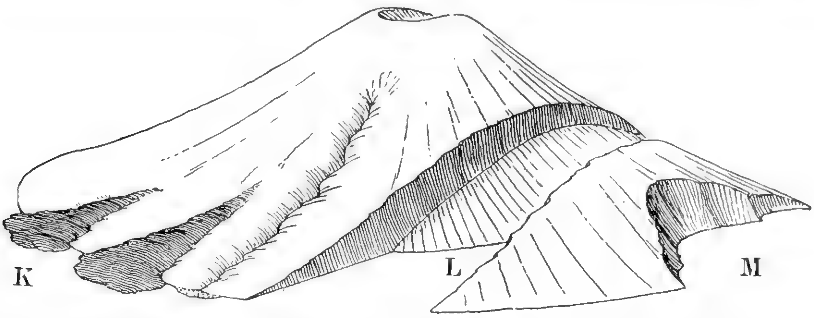

FIG. 17. DIAGRAM OF EMBAYMENTS AS IMAGINED ON A NON-SUBSIDED VOLCANIC ISLAND; *K*, between two advancing lava flows; *L*, in a transverse down-faulted trough; *M*, in a landslide cavity.

planation, for he was convinced that the valleys of the land, be they the short radial valleys such as he saw on the island of Tahiti, or the great complex of valleys such as he observed in the Blue Mountain plateau of Australia, are the product of subaerial erosion which works only above sea-level; it was for this good reason he concluded that a valley which is prolonged in a bay necessarily indicates submergence. This point is evidently important; for if a bay occupy a reentrant between two salient lava flows, as at *K*, Fig. 17, such as occur on the Fiji island of Taviuni, where recent volcanic action has taken place; or if a bay occupy part of a down-faulted trough or bight in a volcanic cone, as at *L* or *M*, such as perhaps occurs in the Fiji island of Moala; or if a bay occupy a large caldera, like that of Totoya, already mentioned,

FIG. 18. DIAGRAM OF PART OF THE SAME ISLAND AFTER SLIGHT DISSECTION AND PARTIAL SUBMERGENCE, showing reentrant embayments at valley mouths, *N*, *P*; and around the ravine sides of a down-faulted trough, *O*, and of a landslide cavity *Q*.

no subsidence would be thereby proved, inasmuch as these peculiar and easily recognizable forms can be produced by volcanic action either at or below or above sea-level: yet if the sides of an embayed bight *Q*, or trough *O*, are ravined, as in Fig. 18, and each ravine descends to a cove

in the shoreline of embayment, the side coves prove submergence after the down-faulting and erosion, even if the embayment of the down-faulted space does not; and such is the case in Moala: likewise, small embayments in a dissected caldera wall prove submergence, and such is the case in the ring-island of Totoya.

The Embayments of Barrier-Reef Islands.—But to return to our coral reefs. If it be true on general principles that the embayments of a dissected central island demonstrate that submergence took place while the encircling barrier reef grew upward, is it also true that the central

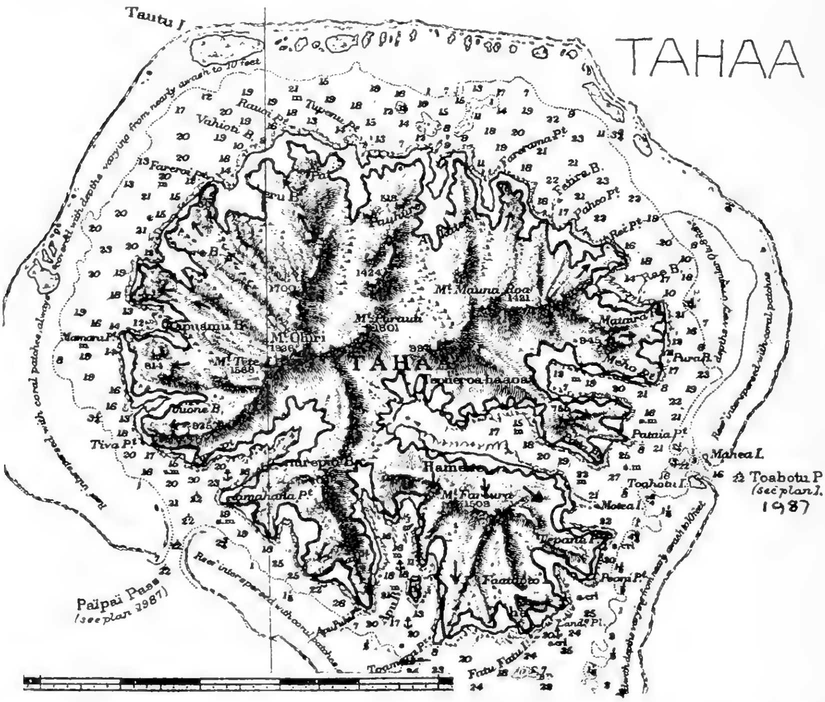

FIG. 19. BRITISH ADMIRALTY CHART OF TAHAA, SOCIETY ISLANDS. The outermost belt, with curved lines of fine print, is the barrier-reef flat; the lagoon is dotted with soundings in fathoms; a narrow fringing reef follows most of the present shore line; delta plains are blank, between the present shore line and the more sinuous original shore line (added in a heavy line) caused by submergence of the maturely dissected volcanic cone.

islands within barrier reefs are so generally embayed as thereby to establish, for barrier reefs at least, the truth of the subsidence theory? Yes, abundantly so; and not only are they elaborately embayed, but their embayment has long been represented on charts and stated in descriptions. Ninety years ago the same two missionaries who first suggested that coral reefs might be formed on wave-cut platforms, described the island of Tahaa, Fig. 19, in the Society group as distinguished "by the number, breadth and commodiousness of its harbors, with which the

whole coast is indented, some running quite into the heart of the country"; thus its outline is made so irregular that the natives compare it to a cuttle-fish, "the projecting headlands and intrusive creeks resembling the many tails or tentaculæ" of that animal. I went around the lagoon of Tahaa in a small motor boat, passing all its spur-end points and entering some of its larger bays, taking time to note the form of the spur-ends where they are cut off in low cliffs, and to sketch the inner border of the bay-head delta plains, in order to reconstruct the intricate salients and embayments that its shores would possess if the spurs had not been a little cut back, and if the deltas had not been built forward. The result is shown by the innermost and strongest black line of Fig. 19—the outermost line is the barrier reef—and it appears to me to be a result of a very striking nature. The small arrows on the spurs represent the dip of lava flows and ash-beds: their radial arrangements shows that the island represents a single volcanic cone, elaborately dissected and partly submerged. Evidently enough the bays would be much longer and more branching than now, if the deltas were removed; and as evidently the spur-ends would not be much longer than now if their original points were restored; but most evident of all, the outline thus reconstructed can be explained in no other way than by the submergence of an elaborately dissected volcano.

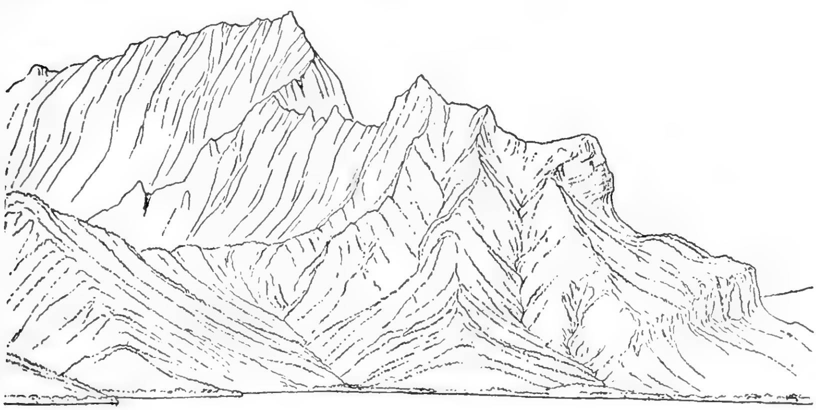

FIG. 20. SKETCH OF PART OF THE DEEPLY DISSECTED VOLCANIC MASS OF RAIATEA, SOCIETY ISLANDS. The embayment of the shore line, diminished by deltas, is not clearly shown because of foreshortening. Fig. 5 is a bay in the same island.

Let it not be supposed that Tahaa is of exceptional pattern. The neighboring islands of Raiatea, Fig. 20, was instanced by Darwin seventy years ago as possessing "those deep arms of the sea . . . which penetrate nearly to the heart of some encircled islands." I gave two days to the leisurely circuit of its lagoon. How wonderfully its original shape is transformed! How deep are the valleys between the sharp-crested

ridges! How gently the spurs slope down, hardly nipped at their ends, into the enclosed lagoon! Again, the Fiji islands make one of the groups in which Dana found many embayed islands to support Darwin's theory, yet that group has been said by some observers to occupy an area not of subsidence but of elevation, because elevated reefs occur on some of the islands. Such a statement is geologically altogether inconclusive; for the absence of elevated reefs on many members of the Fiji group shows that they have not suffered elevation. I saw eighteen of the Fiji islands on my voyage, and sixteen of these had embayed shorelines; the other two showed elevated reefs, as yet little dissected and hence lately elevated. A willing witness to subsidence in Fiji is the little island of Ono, Fig. 21, of mountainous form and irregular outline. A more

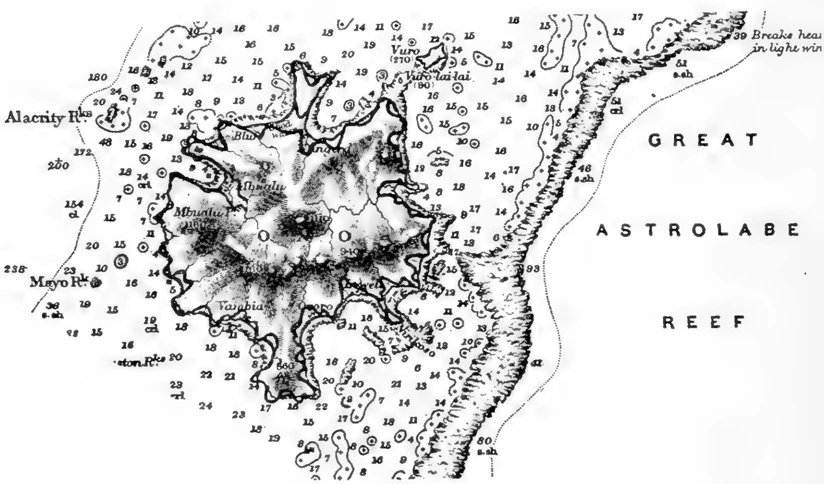

Fig. 21. British Admiralty Chart of the Embayed Island of Ono in the Great Astrolabe Reef, Fiji. The shore line of submergence is added in a heavy line. The larger island of Kandavu, Fig. 23, lies next southwest.

striking example is the larger island of Ka-ndá-vu, Fig. 22, next southwest of Ono; there the mountains are higher and the embayments are more pronounced; they indicate a recent subsidence of at least 600 or or 800 feet. When this is taken in connection with the elevated reefs of Fiji, some of which have been recently uplifted from 600 to 1,000 feet, a gentle warping of the ocean bottom is indicated; but that is not a surprising matter.

The Surprising Case of Ka-ndá-vu.—Indeed, the only surprising thing in association with the beautiful island of Ka-ndá-vu is, not the embayments of its shoreline, not the strong subsidence to which the embayments testify, but the statement regarding the island made by the chief advocate of the still-stand theory of outgrowing reefs: he wrote, several years after his visit to this island:

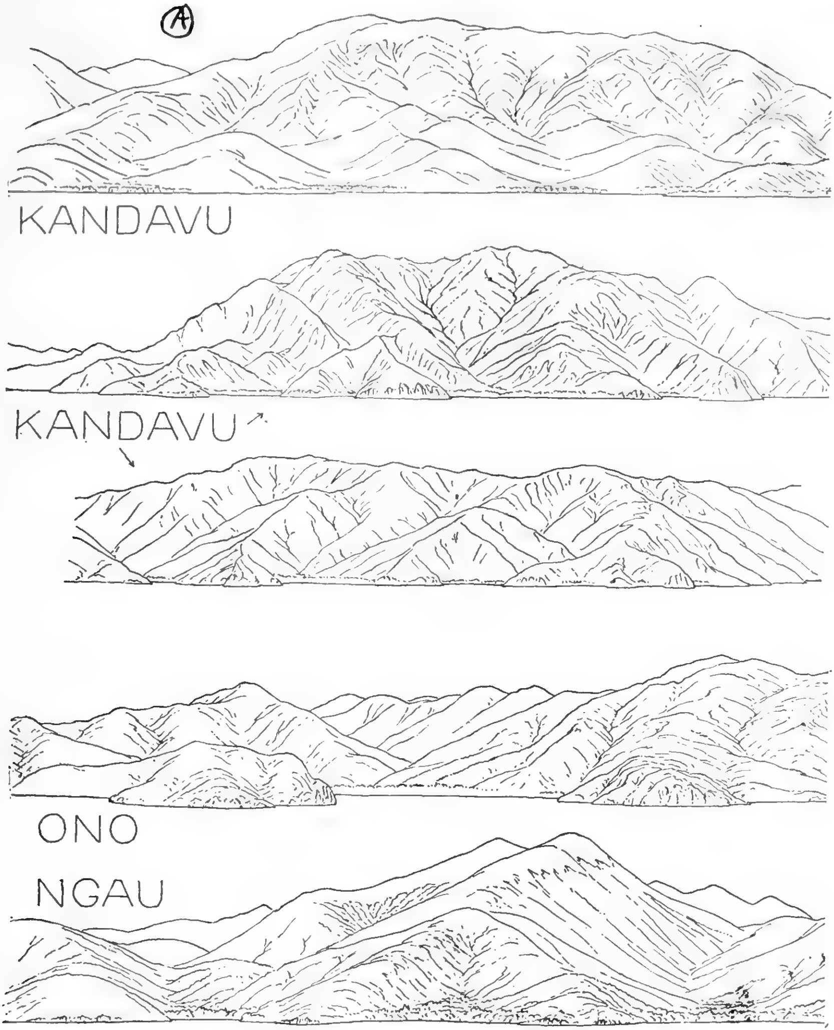

FIG. 22. SKETCHES OF KANDAVU, ONO, AND NGAU ISLANDS, FIJI, showing maturely dissected volcanic masses, with embayed shore lines due to submergence; the bay heads are occupied by deltas; some of the land heads are cliffed more than usual.

It was here that, not being able to apply Mr. Darwin's theory in explanation of the phenomena of the Kandavu reefs, I commenced to doubt it altogether. . . . The more observations accumulate the more does it seem to me probable that there never was a barrier reef or atoll formed after the manner required by Mr. Darwin's theory.

That is truly astonishing, indeed astounding! On reading it in presence of a detailed map of Ka-ndá-vu, Fig. 23, or still better in presence of the island itself, it will be understood more fully than before why the still-stand theory of coral reefs must, in so far as barrier reefs

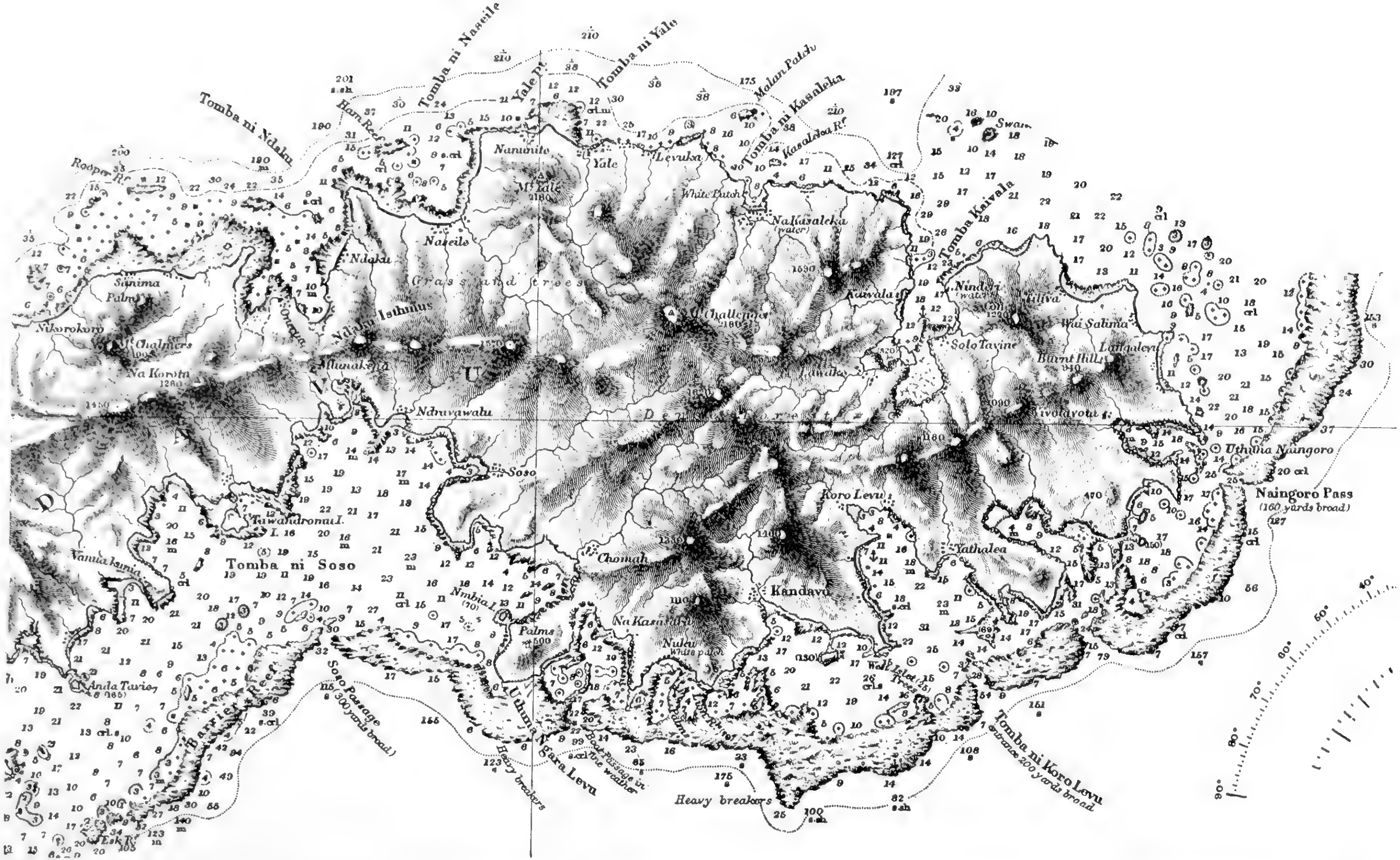

FIG. 23. BRITISH ADMIRALTY CHART OF THE EASTERN HALF OF KANDAVU, FIJI, showing its elaborate embayments. A fringing reef follows the shore line; the barrier reef is broad and continuous on the southeastern or windward side, and discontinuous or wanting on the northwestern side. Scale, about 1 : 87,000, Ono, Fig. 21, lies next northeast.

are concerned, be regarded as a scientific blunder and its publication a bar to progress; for if one island had to be selected from all the islands of the Pacific as decisively favoring Darwin's theory, that island might well be Ka-ndá-vu. Yet hardly less unwarranted than the above quotation is the assertion by the same author that the still-stand hypothesis is in harmony with Dana's views of "the great antiquity and permanence of the great ocean basins"; for if there was any one man who believed that the bed of the ocean basins has not always stood still, but has sometimes subsided, that man was Dana.

In view of all this, it is inevitable that any hypothesis which postulates a fixed relation between the island foundations of coral reefs and the level of the surrounding ocean must be rejected. It may seem overbold thus on the ground of physiographic evidence summarily to set aside certain hypotheses that have been accepted by able investigators; and so indeed it would be had those investigators recognized the occurrence of embayed central islands, and had thereupon said: "Truly these embayments appear at first sight to be drowned valleys, but further study shows them to be of quite different origin, independent of subsidence"; but unfortunately they said nothing of the kind; they took no account of embayments at all. It is therefore well warranted to say, in view of the widespread occurrence of embayed central islands, that the postulate of a fixed relation of island mass to ocean surface is inadmissible. Theories of coral reefs and theories of ocean basins must include the possibility of a mobile ocean floor that carries oceanic islands up or down as it rises or subsides, or of a variable ocean surface that, as it subsides or rises, allows the emergence or submergence of still-standing islands.

The Evidence of Elevated Reefs.—We have thus far considered chiefly barrier reefs at sea-level. Let us now ask what testimony elevated reefs offer, for elevated reefs were specified on an earlier page as competent and communicative witnesses, whose testimony must be heard. But in order to appreciate the value of this testimony, let it be clearly understood that the still-stand theory requires elevated reefs to rest conformably on non-eroded volcanic slopes, because according to this theory, reefs must lie on a slope that has never subsided from a higher stand in which it might have suffered erosion; while the subsidence theory as definitely requires elevated reefs to rest unconformably on a slope that was eroded before it subsided.

An elevated reef, standing 20 or 25 feet above sea-level, has long been known to form a plain of variable width on the border of the Hawaiian island of Oahu, especially along its southern and western sides. The conditions of its origin have been much discussed. That it was formed during or after a time of submergence is clearly proved by

the following considerations: Oahu consists of the remains of two great volcanoes, an older and more dissected cone forming the smaller, western part of the island, and a younger and less dissected cone forming the the larger eastern part. Some of the valleys in the older western mass,

FIG. 24. A LAVA-BED SPUR BETWEEN TWO BROAD VALLEYS OF THE WEST COAST OF OAHU, Hawaii. The valley floors are entered by the limestones of the elevated reef which forms the coast plain.

Fig. 24, are one or two miles in width at the shoreline, and are enclosed by high, narrow, steep-sided spurs, on the flanks of which gently inclined lava beds outcrop in great number. The original floor of the valleys is not now visible, because each valley is occupied, in its shoreward part at least, by the lagoon-limestone plain of the elevated reef: the floor of volcanic rock must be, as well as one can judge by the slope of the valley-side spurs, hundreds of feet below the limestone plain; and this inference is confirmed by the depth of several artesian wells in limestone or non-volcanic beds. Hence the island must have stood hundreds of feet higher than now when the valleys were eroded, and must afterwards have subsided hundreds of feet in order to allow the lagoon limestones associated with the elevated reef to be deposited in the valleys. Since then, a moderate elevation with resulting erosion has taken place; and afterwards a still more moderate depression, for on the south side of the island the branching bays of Pearl harbor are nothing more or less than valleys eroded in the elevated reef plain and then drowned. The present sea-level reef of Oahu was formed in association with the depression that formed Pearl harbor.

Elevated reefs are found on many islands in the larger archipellagoes of the western Pacific. In the Philippines the island of Cebú is

terraced with reef limestones which rest unconformably on an eroded foundation of older rocks; and in such a case, as well as in Hawaii, the foundation mass must formerly have stood at least as high as now in order to suffer erosion; it must then have been submerged to the level of the highest limestone terrace at least; and it must finally have been uplifted to its present altitude. It is of course possible that the terracing reefs may have been formed during pauses in a slow emergence following a rapid submergence; but it is also possible that they were formed during pauses in a slow submergence followed by a rapid emergence; and it is again possible that some terraces were formed during pauses in submergence, and others during pauses in emergence. Nothing less than close study of the terracing structures will suffice to determine which of these possibilities corresponds to the actual occurrences of past time; but while we are waiting for such study, it is fair to quote this case as demanding submergence as a factor in the formation of the reefs in question, and as thereby warranting the postulate of submergence in other cases. Many other examples of unconformable elevated reefs might be cited: they all testify as unequivocally to the submergence of the eroded reef foundation before the reefs were formed or while they were forming, as to the emergence of the compound mass after the reefs were formed.

Which Theory is Best?—In view of the various sea-level and elevated reefs in situations so significant as those now mentioned, can any one who carefully deduces the consequences of the three hypotheses thus far presented, hesitate for a moment in making his choice among them? In the case of sea-level barrier reefs, where are the confluent deltas, projecting outside of a non-embayed initial shoreline, as demanded by the hypothesis of outgrowing sea-level reefs on still-standing islands? Where are the cliffs around a non-embayed shoreline, as demanded by the theory of veneering reefs on wave-cut platforms? And where are not the reentrant embayments, with small deltas at their heads, as demanded by the hypothesis of upgrowing barrier reefs on subsiding foundations! In the case of elevated reefs, where are the unworn volcanic slopes beneath the steeply inclined talus of coral waste, as required by the theory of outgrowing reefs; or the truncated platforms beneath a coral growth of small thickness, as required by the theory of veneering reefs? And where are not the unconformable contacts of reef limestones upon an eroded foundation slope, as required by the subsidence theory!

The Origin of Atolls.—The confirmation provided for Darwin's theory by Dana's principle of shoreline development is as admirable and abundant for sea-level barrier reefs as is that provided by the unconformable contact of reef-mass and foundation for elevated reefs: but let it be explicitly noted that neither of these confirmations applies directly to sea-level atolls. Those inscrutable islands stand alone in the sea,

without witnesses to reveal their origin. They have been described as monuments over drowned volcanoes; they are monuments truly enough, and it has lately been shown that the Bermuda reefs have a volcanic mass beneath them; but no direct proof has been found that any sea-level atoll in the Pacific is built upon a volcanic foundation, much less that the foundation has subsided. The deep boring on the atoll of Funafuti in the Ellice group has led different students to different conclusions, though it seems to me that the evidence for subsidence is strong: unhappily the boring reached no volcanic rock. Nevertheless, it is probable that the atolls of the Pacific have subsiding volcanic foundations for the following reasons. Atolls sometimes occur in association with barrier reefs, as in the Fiji, New Hebrides and Society groups; and in such cases the subsidence of the volcanic islands proved for the barrier reefs may be very reasonably extended to the neighboring atolls. Sea-level atolls are in all cases exactly like barrier reefs, but for the absence of a central island; the process which has produced a barrier reef on a subsiding volcano must, if continued, change it into an atoll; and it would truly be singular if this process, so far advanced in some barrier reefs that their central islands occupy a very small fraction of their lagoon,

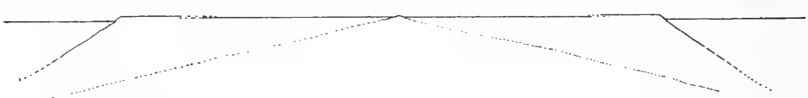

Fig. 25. Cross Section of the Elevated Atoll of Maré, Loyalty Islands, showing the small knob of volcanic rock that rises in its lagoon plain to a less height than its reef rim.

had never continued a little farther; Maré, Fig. 25, the southeasternmost of the Loyalty islands, is a recently uplifted atoll, about twenty miles in diameter, and over 200 feet above sea-level; it has a low knob of eroded volcanic rock near the center of the limestone plain that represents the former lagoon, but the summit of the knob is lower than the reef-rim that encloses the plain, and hence the volcanic summit was below sea-level before uplift occurred. No uplifted atolls have been found to possess the particular structures characteristic of atoll formation by other processes than upgrowth during subsidence. On the other hand, the extensive oceanic subsidence demanded by the occurrence of atoll groups has been objected to as inconsistent with what is known of the origin of ocean basins; but so little is known of their origin that this objection has little force; the theory of ocean basins must accommodate itself to the subsidence that is demonstrated for barrier reefs and made highly probable for atolls.

Atolls Formed by Up- and Out-growth.—Let us now turn aside from the theory of subsidence and consider briefly another theory for the formation of atolls, proposed by the oceanographer who advocated the

still-stand theory of barrier reefs. Let *VVV*, Fig. 26, be a submarine mountain, presumably a volcano, the summit of which lies below the limiting depth of 20 or 25 fathoms, at which reef-building corals can grow. The frail calcareous shells of innumerable small pelagic animals, floating in the shallower waters, fall to the ocean bottom when the animals die, like "an organic rain"; and, in so far as they fall on the mountain, they aid the organisms living there to build it up, *QQ;* and thus eventually a submarine bank is formed near enough to the surface

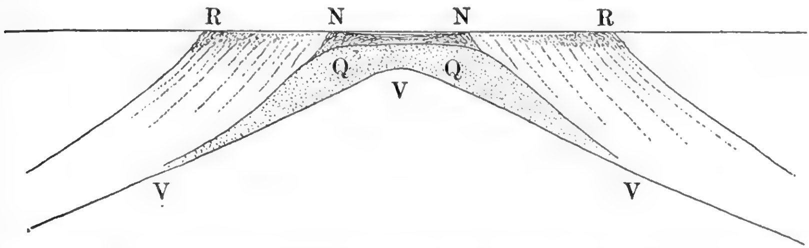

FIG. 26. CROSS SECTION TO ILLUSTRATE THE THEORY OF UP- AND OUT-GROWING REEFS: a submarine volcanic summit *V*, is built up with pelagic deposits, *Q*, and crowned with a reef, *N*, which has been enlarged by out-growth, *R*.

for corals, *NN*, to be established upon it. Then the corals grow outward on their own talus and form an enlarged atoll reef, *RR*, while the older part of the reef is dissolved out to form the lagoon. Such is the hypothesis for the production of atolls by up- and out-growth without subsidence. It is easily conceivable, but no one has yet shown that it represents any actual occurrence. Soundings have truly enough discovered organic deposits on submarine summits, but it does not seem probable that the fine calcareous deposits of the "organic rain" could remain on a summit when it reached depths less than 40 or 30 fathoms; the heavy waves of the ocean would sweep the deposits off into deeper water, and upbuilding would have to be continued by heavier forms of local growth. But it is not known that submarine summits stand still and suffer a capping of organic deposits to grow upwards nearly to the sea surface. So far as islands which rise above sea-level are concerned, their heads are as uneasy as if they wore a crown; emerged summits repeatedly suffer uplift or depression as well as still-stand pauses: it is therefore probable that submarine summits are similarly uplifted or depressed, for uplift and depression of super- or submarine volcanic masses do not result from changes within the masses themselves, but from movements in the suboceanic earth crust on which they stand. If the submarine summits are depressed, they could hardly be at the same time built up to the surface by the slow process of "organic rain"; if elevated, it is certainly singular that they all stop rising in the regions of true atolls before they emerge. Hence this theory is encompassed with improbabilities.

Furthermore, no elevated atoll has been described as showing the structures demanded by this theory; hence the theory stands merely as a possibility without direct support. But an island in the Solomon group has been figured as possessing a volcanic core, *V*, Fig. 27, partly

Fig. 27. Reproduction of a Cross Section of one of the Solomon Islands, much exaggerated vertically.

covered by pelagic deposits, *LL*, other than coral, and these in turn are surrounded by an uplifted coral-reef terrace, *RR*, not so high as the pelagic deposits: and this composite structure has been taken as confirming the up- and out-growth hypothesis just stated. The confirmation is not convincing for several reasons. First, the volcanic summit, *V*, has a greater altitude than the pelagic deposits, *L*, and this would seem to show that the summit had been built up above sea-level before the "organic rain" fell on its flanks. Second, the pelagic deposits, *L*, have a greater altitude than the coral reef, *R*, and this shows that uplift of the cloaked volcano preceded as well as followed reef formation. Third, the threefold structure is vertically exaggerated in Fig. 27; it might be better represented by *VLR*, Fig. 28. Fourth, the contacts of the pelagic deposits with the volcanic cone, and of the reef limestones

Fig. 28. The Same, redrawn with Less Vertical Exaggeration, showing on the left a volcanic slope, *V*, conformably overlaid with pelagic deposits, *L*, and these conformably built upon by a reef, *R*; the threefold mass having been twice elevated. On the right, the three structures, *U*, *J*, *S*, are drawn with unconformable contacts, indicating two depressions and two uplifts.

with the pelagic deposits remain undescribed: perhaps, instead of representing an unbroken succession of submarine deposits, they may be separated by surfaces of erosion, and thus represent discontinuous deposits, as *UJS*; that is, the volcano may have stood above sea-level and suffered erosion for a time, before rapid subsidence drowned it for the receipt of the uncomformable pelagic cover; uplift and erosion of the composite mass may then have taken place before renewed subsidence permitted the formation of the reef; not till then may have come the present uplift of the threefold mass. Changes of this kind may seem cumbrous. If so, let me commend the attentive study of the following example from the new Hebrides.

Uplifted Reefs in the New Hebrides.—On the northwest side of the

island of Efate in the New Hebrides a series of well-bedded, nearly horizontal tuffs, *NN,* Fig. 29, described as containing *Globigerina* and other pelagic foraminifera, is deeply eroded in valley-side slopes of over 800 feet, which descend to the drowned-valley embayment of Havannah harbor; and the slopes are terraced by a number of elevated fringing reefs, *TTT,* which contain abundant and well-preserved fossil corals, and which lie unconformably on the eroded slope of the tuff beds. If

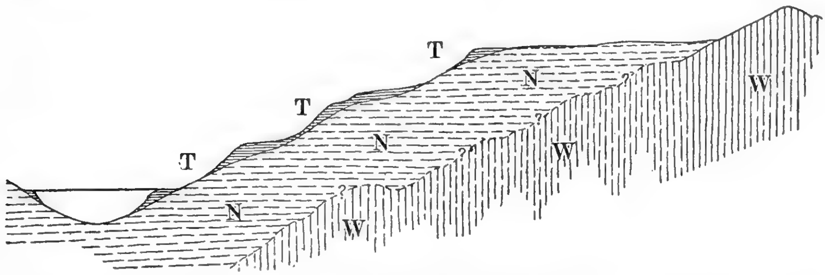

FIG. 29. CROSS SECTION TO ILLUSTRATE THE UNCONFORMABLE CONTACT OF THE ELEVATED FRINGING REEFS OF EFATE, in the New Hebrides group, on an eroded mass of horizontal marine strata, *NN;* the nature of the contact of the marine strata on their volcanic foundation, *WW,* is not known.

this is interpreted in accordance with well-established geological principles, we must conclude that the island stood several hundred feet lower than now when the foraminiferal tuffs were deposited: that it was then raised higher than now for the erosion of the drowned valley of Havannah harbor; that it then subsided low enough for corals to form fringing reefs up to the very top of the eroded slope; and that it was finally raised at least to its present altitude, leaving the valley bottom drowned. Whether the fringing-reef terraces were formed during the last uplift or during the preceding subsidence is not easy to determine; their formation during uplift has been announced by a young Australian observer, but he did not recognize that the truncation of the tuffs demanded previous elevation, erosion and depression. In company with Mr. E. C. Andrews of Sydney, New South Wales, I reviewed the section with the earlier observer's report in hand; and the formation of the reefs during intermittent subsidence followed by rapid uplift, rather than during intermittent uplift preceded by rapid subsidence, seemed an explanation well worth considering. Whether the tuffs of Efate lie on an eroded or a non-eroded volcanic foundation, *WW,* I can not say; but in Viti Levu, the largest island of the Fiji group, similar marine tuffs seemed to lie, at the only point of near-contact that I reached, unconformably on an eroded volcanic slope; if the same relation occurred on Efate, a strong submergence must have taken place after the initial volcano was built up and eroded, and before the tuffs were laid down on its eroded flanks. The absence of details of this kind from the

description of the island in the Solomon group (Fig. 27) makes it for the present an incompetent witness. The upshot of all this is, that the up- and out-growth hypothesis, which explains atolls as the crowns of pelagic deposits built up on submarine foundations, is as yet without support by well-observed facts; and hence that Darwin's theory of subsidence provides a simpler and better supported explanation of atolls than any theory yet invented.

Objections to the Theory of Subsidence.—Are we then to understand that no objections can be raised against the theory of subsidence? Hardly that, for many objections deserving consideration have been urged. First is the objection that an extravagantly large volume of limestone is needed to build atolls on the subsidence plan. This is perfectly true, but it is also true that the outgrowth plan is hardly less extravagant. Extravagance seems sometimes to be the order of nature, as in building up voluminous volcanic cones by eruption through the earth's crust beneath the ocean; some of the cones, if measured from the ocean bottom, are of staggeringly large dimensions. But the best answer to this objection is found in two of the Loyalty islands, next northeast of New Caledonia; they are uplifted atolls 20 or 30 miles in diameter and now standing 200 or 300 feet above sea-level, without a sign of any rock but limestone around their rim, though one of them (Maré) has, as above mentioned, a small knob of volcanic rock in the center of its uplifted lagoon-plain; if the volcanic mass of which the knob is the summit be given a slope such as is commonly observed in volcanic islands of the Fiji group, the thickness of the limestones at the margin of the island must be at least 5,000 or 6,000 feet. As far as this goes, it indicates that heavy limestone masses really do occur beneath the crown of an atoll reef.

A second objection to the theory of subsidence is based on the absence of heavy coral-reef limestones from ancient geological formations. To this it may be answered that, while parts of continents have in the past presumably been transformed by depression into deep ocean floors, deep ocean floors do not seem to have been transformed by elevation into continents; or if they have been, the lofty overtopping atolls then uplifted must, as a rule, have been worn away, just as all lofty mountains and volcanoes of Paleozoic and Mesozoic times have been worn away. The roots of ancient mountains and volcanoes are found beneath less ancient geological formations, but not the summits. Similarly, it is only the base of ancient atolls that would commonly be preserved under less ancient geological formations, and not the tops. Another answer to this objection is that the heavy dolomites of the Tyrol do, by way of exception, represent ancient coral reefs, and thus show that ancient reefs are occasionally preserved.

A third objection to the theory of subsidence is, as above noted, the necessity of a great depression of the Pacific ocean floor in recent geological time over the immense area occupied by groups of barrier reefs and atolls. So great a depression is held by some to stand in contradiction to what is known of the dynamics of ocean basins; but in answer it may be urged that the evidence of strong ocean-bottom subsidence over large areas, as given by atolls, must be added to the little else that is known about the ocean floors before safe inferences can be drawn as to the amount of deformation which their basins have suffered. It may be briefly noted that the inferred contemporaneous lowering of ocean water and the consequent laying bare of all continental coasts, as a result of a great deepening of the Pacific atoll areas, is not necessary; for it may be assumed with much probability that adjacent parts of the Pacific floor suffered a roughly compensating elevation, as Darwin suggested, when the atoll areas subsided, and hence that contemporaneous changes of ocean level were relatively small.

A fourth objection to the theory of subsidence, urged by an eminent geologist, must be regarded as the most singular of all objections. It is as follows: "Upheaval has taken place in areas where barrier reefs and atolls are in vigourous growth. Such an association of upheaval with an assumed general subsidence requires, on the subsidence theory, a cumbrous and entirely hypothetical series of upward and downward movements," and hence is improbable and unacceptable. This pronouncement is, in view of its source, one of the most extraordinary that I have encountered in coral-reef literature. It tempts me to follow for geologists the example of the late William James, who divided philosophers into two categories, the tender-minded and the tough-minded. Let us divide geologists into the same two classes, and among the tender-minded place those who hesitate to accept a theory of coral reefs that involves repeated uplifts and depressions of the earth's crust because such terrestrial uneasiness is mentally distressing; and among the tough-minded, those who are perfectly ready to follow good evidence wherever it leads, even to the cumbrous series of upward and downward movements shown by elevated reefs in Fiji and by Efate in the New Hebrides. It is consoling to remember that James avowed himself to be one of the tough-minded pragmatical lot.

(*To be continued*)

ANNEXATION AND CONQUEST

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IN the minimum program of the Central Organization for the Study of a Durable Peace, the first article reads as follows:

> No annexation or transfer of territory shall be made contrary to the interests and wishes of the population concerned. When possible, their consent shall be obtained by *plébiscite* or otherwise.

On this article I am asked by the executive committee of the Central Organization to present my comments.

Its essential features may be summed up in these words: "No right of conquest; no annexation by force." Its thesis is vigorously urged by Immanuel Kant in the second paragraph of the first section of "Perpetual Peace." Says Kant:

> A state is not a possession or a patrimony like the soil on which it has its seat. It is a human society subject to the authority and disposition of none but itself. Since, like a stem, it has its own roots, to incorporate it as a graft into another state is to take away its existence as a moral purpose and to make of it a thing. This contradicts the idea of the original compact, without which no authority over a people can be conceived. Everybody knows into what danger, even in the most recent times, the supposed right of thus acquiring states has brought Europe. . . . This has been looked upon in part as a new kind of industry, a way of making oneself powerful through family connections without putting forth personal effort, in part also as a way of extending one's landed possessions. . . . Thus the subjects of the state are used and abused to be handled at will.

It can not be denied that the views above quoted conflict seriously with tradition, theory and practise in past European history. The curse of modern Europe is its burden of history. Every generation is filled with remembrance of the futile glory of past wars, with futile hatreds of the people against whom the wars were fought. The teachings of the schools furnish many of the standing incentives to war. Through these agencies the war-system has perverted and poisoned all lessons in history, in patriotism and even in religion. The way out is to start afresh. That this may be possible is one of the cheering lessons to be drawn from European history. For example, my friend and teacher, Andrew Dickson White,[1] reminds me that "the religious wars which had been going on for well over a thousand years were forever ended by the Treaty of Münster in a universal feeling of shame and dis-

[1] In a letter dated Cornell University, January 27, 1916.

gust." So we may hope that the present inexpressibly tragic confusion may end in the stable development and rational development of international law.

The article under discussion represents in spirit a great advance in international law. It stands for the right of small civilized nations to autonomy and integrity. It opposes the dismemberment of any nation, large or small. It removes certain standing incentives to war by eliminating supposed advantages of victory. To put this rule into operation at the end of the present war would add enormously to the stability of civilization.

In the following pages I shall briefly treat various details under five heads: (1) The Assumed Right of Conquest, (2) the Use of the *Plébiscite,* (3) Secession and Nationality, (4) Colonial Adjustments and finally (5) Conclusion.

I. The Assumed Right of Conquest

The great argument against the right of conquest lies in its fundamental injustice. It furthermore interferes with the stability of society. The conquest of the whole or part of one civilized state by another involves an assault on the well-being of all. The conquered state at once encounters serious interference with its own manners and customs. It naturally tends to resent this interference, and soon its resentment becomes an intrusion into the established discipline of the victor. Both these conditions followed the annexation of Alsace-Lorraine, making this region, on the one hand, "the nightmare of Europe" (*le cauchemar de l'Europe*), and, on the other, the "wound in the side" (*la plaie dans les flancs*) of the great empire to which it was forcibly united. Whatever the motive of such annexation, it necessarily leads to dissatisfaction in the smaller group and disunion in the larger. Moreover, the precept that "Might makes Right" or its sophistical equivalents that "Might creates Need" and "Need creates Right," whether applied to men or to nations, is offensive to the moral sense of civilized humanity. For example, the nationality of Belgium must be absolutely maintained. Anything less than this would leave Europe wholly unstable. Serbia and Montenegro should also be restored.

An argument for annexation by force frequently advanced is this; that to guarantee future peace and prevent attack from outside a fringe of alien territory must also be secured. Dr. John Mez writes:

> The creation of so-called buffer states may indeed from a military and strategic viewpoint serve those ends of securing the national boundary, but the experiment of securing peace by such conquest has been tried several times in history and proved a failure every time. Bismarck had intended merely to seize Alsace and the German-speaking parts of Lorraine, but military experts insisted that a portion of the French-speaking district should equally be taken for

strategic reasons and "in order to secure the peace." It was said: "The fortress of Metz is worth 100,000 soldiers in case of another war." Thus Bismarck was induced, almost against his will, to consent to the annexation of Metz and the region about it. Peace insurance by conquest is one of the greatest fallacies of history. It is distinctly and naturally *disadvantageous* to both victor and vanquished, and, instead of preserving the peace, it necessarily defeats that end, since out of it grows the inevitable desire for "wars of revenge" in the nations despoiled. Apart from this it is a gross injustice to the inhabitants of the conquered province itself. It is also immoral, creates a dangerous precedent which in some future day may be equally applied by other parties. Here is the main reason for protesting against the idea of conquest of territory, even if alleged to be made not for gain, but to make a country secure from attack or to ensure peace—a shallow phrase—used over and over again as an excuse for the crime of a large-scale robbery.

The system of "scientific frontiers" leaves a boundary marked by dissatisfaction and surrounded by suspicion and hate. A wise Alsatian once said to me: "The best boundary fortress is a contented people." ("*Die beste Grenzefestung ist ein zufriedenes Grenzevolk.*")

II. The Use of the Plébiscite

Rejecting then the principle of the use of force as a means of extending jurisdiction, we may consider some of the details involved.

First, as to the "interests and wishes" of the population concerned. These may not altogether coincide if by interest one means financial advantage. In general, the more cultured a body of people, the more will interest and wishes approach agreement. For with advanced people wishes rise to have an intellectual value and interests a moral value unknown to barbarous races. With barbarous races, the desire to be let alone outweighs most forms of economic interest, as these necessarily involve a degree of personal restraint or collective discipline.

How then shall we ascertain "interests and wishes" in a given case? Manifestly we cannot trust a victorious nation. Two methods remain, the one an international tribunal, the other a vote of the people themselves in the conquered district. As to the first, the results of international commissions or "concert of powers" have not been thus far encouraging, but the sources of failure lay in their partisan composition. In the Balkan crisis, most members of the concert, conventional diplomats, represented interests which hoped to gain by confusion, and the present war has its excuse if not its cause in the disorder resultant from the incongruous adjustments of Balkan affairs in the Treaties of London and of Bucharest.

On the other hand, a wise, impartial and non-partisan commission is possible if the several states will together set up a righteous standard. In a well-ordered continent just action may be expected from nations as well as from individuals or corporations. "Peace is the duration of law," that is, of justice.

The *plébiscite* or ballot is a device for ascertaining the will of the people. It is not clear that this can ever be safe and effective in determining the fate of any disputed district of Europe. The process can have no value unless voting rests on intelligence and the ballot is fully guarded, with a secret vote and the absence of all duress, intimidation or bribery. And as some form of duress is a regular accompaniment of the suffrage in many parts of Europe, we can hardly expect the stream to rise above its source. Even in the best-ordered districts a *plébiscite* as to national allegiance would be fraught with embarrassments. In case of any change in this regard public feeling would run high in both the states concerned, as well as in the strip of territory to which the *plébiscite* is applied. This condition would encourage intrigue, with manipulation of public opinion. The struggle for ascendancy would interest the rest of the world, and sympathies racial, political religious, would form a disturbing element far beyond the limits of the regions concerned. "I can imagine," says Professor Walter Rauschenbusch,[2] "a *plébiscite* turning into an active volcano. . . . This provision would operate as an almost insuperable check against any change. It would give the population no initiative, only a veto."

At once, in any plan for *plébiscite,* three problems arise: (1) How large shall be the voting units? (2) What rights shall the people have within the nation to which they may assume allegiance? (3) To what extent are the principles of toleration set forth in Article 2, democratic equality before the law, religious liberty and tolerance of language, to be guaranteed in the chosen relations? Allow me to discuss these problems at some length and by venturing on certain illustrations.

Before the war between Prussia and Denmark, Schleswig as a whole, being very largely occupied by German people, had the choice been offered, would doubtless have voted for transfer to Germany. But had smaller voting units been adopted, northern Schleswig or its city of Flensburg would certainly have elected to remain in Denmark, while the body of the province would have attached itself to Germany. Such a decision would not have necessarily been because northern Schleswig is Danish, a fact in itself of secondary importance. The determining factor might have been that, speaking Danish rather than German, the people were subject to minor persecutions on that account. Being assured of such tolerance as our Article 2 contemplates, they might have elected to remain in Germany, for presumably their financial interests would be better served within the German *Zollverein.* With fair play, old hatreds soon die out. It is not necessarily language or race which determines choice of allegiance. Partly it may be tradition, partly the feeling of equality before the law, and for the rest, mainly continuity of manners and customs.

[2] In a letter dated Rochester, February 9, 1916.

In Alsace-Lorraine, however, for example, the results of a *plébiscite*, if conducted before the present war, would have been determined by other questions than that of simple preference for France or Germany. The region inhabited by people of French blood would assuredly not have wished to detach itself from that where German blood predominates and where a German dialect is spoken by the peasant classes. A common experience had inspired in "Alsace-Lorrainers" a feeling of like nationality. Their first allegiance was to *Alsace-Lorraine*. Undoubtedly Alsace and Lorraine, of differing speech and origin, had been welded into one common experience. This fact is expressed in the doggerel verse,

Français ne peux,
Prussien ne veux,
Alsacien suis.

So the first choice of these people would have been to stand together, their next, local home rule in details of custom and language. This they had had under France, but not under Germany. Politically, the first preference of most would no doubt have been independence, an unfortified neutrality alongside of Switzerland, Luxembourg and Belgium. They would thus have formed a republic of free men, a bridge connecting the culture of France with that of Germany. As their business interests allied them to the rest of the Rhine valley, they might have been glad to remain in the German *Zollverein* if freed from linguistic and other restrictions. Failing in this, they might have chosen to be incorporated into the republic of Switzerland of which Mülhausen once formed an integral canton.

The former bond of Alsace-Lorraine to Germany rested on business relations and on the large influx of German manufacturing interests in Strassburg and Metz. Its persistent opposition was due largely to Germany's failure to grant full citizenship, leaving the people as "*Deutsche zweiter Classe*" inhabiting "*Reichsland*" or Territory of the Empire. Resentment against this condition was stronger in German Alsace than in French Lorraine, partly, no doubt, because more French than Germans had emigrated from the land to escape Pangermanist influences. Matters of language became really important only through attempts to suppress the use of French.

It is not important to the unity of a great nation that all its people should speak the same language. Stability is assured by equality before the law and the recognition by all that under a common government their individual personal rights are assured. In the words of Albert Oeri of Basle,

> A compatriot who thinks our thoughts is nearer to us than one who merely speaks our tongue.[3]

[3] "*Pour un Suisse un compatriote de langue diffirente est plus cher qu'un étranger de la même langue.*"

Most attempts to define nationalities by race lines are bound to fail. Language and race cross every border, sometimes producing inextricable mixtures of blood and tongues. Kinship in spirit is more vitally essential. The ideal of a unified nation with one race, one speech and one religion is a reactionary one regarded as necessary to an oriental despotism, but out of place in modern international Europe. To illustrate further, the complexities of the political problems sure to arise at the conclusion of the present war, I again make use of Alsace-Lorraine in illustration. If at the end of the war a *plébiscite* were to be offered to this district, the problem would be by no means simple. Several possible alternatives would present themselves, each having formerly had its special advocates. The provinces could (1) remain as at present, the people being still "*Deutsche zweiter Klasse*," living on "*Reichsland*," or territory of the empire; or (2) become part of the Grand Duchy of Baden; or (3) remain in Germany, but as one of the autonomous or self-governing states of the empire; or (4) become a free state or republic within the empire, comparable to the free cities of Hamburg, Bremen and Lübeck; or (5) become an independent nation like Switzerland, thus forming one of a series of buffer states between France and Germany, either (*a*) unfortified like Luxembourg, perhaps retaining the commercial advantages of the Imperial *Zollverein*, or (*b*) armed like Belgium and Switzerland, or (6) return to France in spite of the fact that in the centralized republic the district would as before be reduced to three departments or local jurisdictions (Haut-Rhin, Bas-Rhin, Moselle) instead of forming one united province of "Elsass-Lothringen," as at present. Or, as further alternatives, neither of them I believe acceptable to the inhabitants, the area might (7) be divided crosswise, separating Lorraine which is largely French, from Alsace, where the original stock was Germanic, or (8) divided lengthwise, returning the French-speaking communes on the Moselle or along the summits and west flank of the Vosges to France, retaining and leaving the rest of Alsace and of Lorraine in Germany. Either of these propositions would be regarded as mutilation for reasons I try later to make clear.

Finally in any discussion of this particular problem must be weighed the claim of France that a *plébiscite* at the present epoch would be unwise and unfair, as the will of the provinces for all time was indicated in the protest of the retiring Alsatian members of the French National Assembly in Bordeaux in 1871. The partial colonization of Strassburg and Metz with Germans should not affect, it is claimed, the status of the districts which, as aliens, they have entered.

I have chosen Alsace-Lorraine as an example of the difficulties of a *plébiscite* even in a highly civilized region. Before one could be under-

taken, the different alternatives should be clearly announced, as also the proper provision for the safeguarding of the rights of minorities. Respect for minority rights is one of the best tests of the enlightenment of a nation. While in political questions majorities rule within accepted or constitutional limits, the personal or social rights of the minority should not be abridged or taken away. The size of the voting unit hinges in some degree on this question. It must rest on wise political judgment. It would be possible to divide Schleswig satisfactorily, as the Danish or discontented portion is geographically a part of Jutland in Denmark. It would be unsatisfactory to dismember Alsace-Lorraine, Finland or Bohemia. A similar question has been bitterly argued in Ireland, first as to the autonomy of Ireland as a whole, and second, in case of division, as to the integrity of northern Ireland, the ancient Province of Ulster. But the exclusion of Ulster from Irish Home Rule would leave the same question of the rights of minorities. For of the nine counties of Ulster all but three, Down (Belfast), Antrim and perhaps Derry (Londonderry), would choose to be linked with the rest of Ireland. Throughout the island there are "Unionists" and "Nationalists," just as in Alsace-Lorraine there are "French-minded" and "German-minded" people (*"französisch-gesinnt" und "deutsch-gesinnt"*) in every commune. Any decision of the majority should leave the rights of the minority intact.

III. Secession and Nationalism

It is clear that no denial of the right of conquest could be made retroactive. To attempt this would throw Europe into confusion. With time, vested rights become entangled with vested wrongs, and any effort to correct the latter, suddenly and as a whole, would involve a general overturn of government. For this reason, the "right of secession" of any province or group of people can not be unconditionally admitted. It exists only in connection with the larger right of tolerance of race, religion and language. The world is concerned in all these problems, as an imperfect solution endangers the world's right to peace. But they can not be settled by a reversal through secession or a conquest of *revanche*. They can be finally adjusted only by a generous tolerance with the recognition of the rights of minorities on the part of the general government. Without such tolerance any conquered province "will remain a wound in the side" of a great nation, finally impairing its integrity.

To concede the right of secession by *plébiscite* would involve consideration of the variant claims of a dozen districts more or less discontented with their present lot. It will therefore be necessary to proceed "on the pragmatic principle of letting sleeping dogs lie," not raising more complications than are strictly necessary. Recent attempts to

reconstruct the map of Europe on the basis of nationalism have shown their own futility. Race and language, as I have already remarked, interlock in every quarter. In the Balkans, for example, every race has overflowed into all its neighbors, its migrated members having meanwhile acquired new languages and new customs.

In general, the grant of autonomy with home rule in intimate matters is a far more practicable solution than independence. But independence once secured is preferable to unwilling or undesired autonomy within a larger nation. In all these great affairs the burden of proof should lie against change in actual status unless conditions have become wholly intolerable. A compromise empire or coalition such as Austria-Hungary, for example, is preferable as an agent in civilization to the frank discord which would follow dismemberment. The disorder now existing among the independent states of the Balkans well illustrates this. Whether autonomy be a solution in any particular case or not must depend on the actual conditions. To grant independence to all more or less suppressed races, would involve Europe in the anarchy of the Middle Ages.

Nationality for example, has been more or less insistently demanded, by Ireland, Finland, Poland, Bohemia, Alsace-Lorraine, Ukraine, Slavonia, Bosnia, Macedonia, Armenia, Albania, Korea, India and the Philippines. The claims of these districts are of varying plausibility, and in some cases autonomy in a degree has been already granted. Others are in a more or less anarchistic state in anticipation of home rule. To grant autonomy with equality before the law, and especially equality of language, would solve many of these difficulties. And not many of the others could be adjusted by shifting the boundaries in the interest of nationality.

The districts severed from Bulgaria, or at least refused to her at the treaty of Bucharest, should have their relations reconsidered by some compètent tribunal, any form of *plébiscite* being, in this connection, impossible. The wholesale suppression or ejection of a large percentage of the inhabitants of Macedonia, Thrace, Dobruja and Novibazar, has made final justice an impossibility. Upwards of a million peasants in the various Balkan countries were homeless refugees in the early part of 1914. The number of these has since been reduced, but only by death. For this region there is no way out, except through tolerance of language, race and religion, all this being comprehended in the phrase, "Equality before the Law." Beyond this their economic needs demand a common customs-union which shall abate the heavy tariff burdens laid on each other and on themselves.

Even within the boundaries of would-be nationalities there may exist great injustice. In Galicia the Poles, annexed against their will but still as landlords retaining a considerable degree of freedom, treat

with great harshness the agricultural population largely composed of Ruthenians or Little Russians. In Russia both Poles and Ruthenians (Ukrainians) find themselves more or less oppressed, while all parties join in the persecution of the Jews, and the Jews in turn find means for a certain degree of revenge.

In certain recognized states, for example the Ottoman Empire, which is merely an army of occupation holding a population of five times its own number, any considerable degree of self government or even ordinary tolerance would mean dissolution.[4] If the Turks did not rule, the people would and they would insist on the "bearable life" not attained by any race under Turkish rule. It is claimed on good authority that recurrent massacres were absolutely necessary if Ottoman rule were to be maintained. Except through extremes of violence[5] the "grim, raw races" of the Near East could not be held in check. A sovereignty maintained by such means is not a nation in any proper sense, and has no claim to recognition in a sisterhood of states.

IV. Colonial Adjustments

Thus far in this discussion, I have considered only the problems of annexation in Europe. These concern relatively homogeneous populations, accustomed to a degree of self-government and to some process of voting. The colonial systems of the various nations offer an entirely different set of problems. In dealing with people wholly barbarous, there may at times arise a necessity requiring domination or even conquest on the part of a civilized state. President William Howard Taft has suggested that "while the rule of Article I. might be generally true, there might be exceptions in which the progress of the world would require a departure from the principle where the people are ignorant or depraved, or where they otherwise show their unfitness for self government by continued anarchy."[6]

That such exceptions may occur we must admit, although the "right of conquest" as applied to them is fraught with serious dangers. Such as may be allowed should be not a "right" but a "duty." The greed of exploitation is often a ruling motive in bringing law and order to feeble and discordant peoples. Decisions on questions of this sort ought ultimately to be more or less international. The purpose of occupation should be the general welfare, not merely the protection of exploiting interests.

[4] "To concede absolute equality would be to commit suicide."

[5] "In our reconstitution of the Ottoman empire administrative conformity must be absolute. Autonomy is treason. It means separation. Our Christian compatriots shall be Ottomanized citizens. We shall no longer be conquerors and slaves but a new nation of freemen." (Riza Bey, quoted by John Macdonald, "Turkey and the Eastern Question," 1913.)

[6] In a letter dated New Haven, January, 1916.

The relations of the United States to the conditions in Mexico may be considered in this connection. They afford an illustration of the difficulties which beset a nation which is desirous of seeing order maintained in a disorderly neighbor, but wishes at the same time to avoid armed intervention, costly and dangerous, as likely to entail occupation and ultimately a most undesired annexation. Mexico was for three years in the hands of rival groups of bandits, with no certain prospect of any orderly adjustment of its affairs. The United States has thus far (February, 1916) refrained from intervention in the face of various provocations, such restraint seeming to be, in the opinion of most, the lesser of the two evils. Should military occupation ever be found necessary, it is understood that it should be undertaken only with the cooperative sanction of the leading states of South America, and with no intention of annexation of any part of the territory occupied.

An over-seas district controlled or affiliated for any purpose by a civilized nation has received the general name of "colony." In this sense a colony may range from a coaling-station to a continental dominion or commonwealth.

The civilized colonies which have risen to be independent nations, affiliated with but not controlled by the mother country, are all in the temperate zones, and nearly all are outgrowths from Great Britain. These are Canada, Australia, New Zealand and South Africa, and no present question of annexation or conquest concerns any of them.

The holdings which are chiefly serviceable as coaling-stations or as fortresses guarding channels of trade are also mainly British, and apparently none of them is directly concerned in the outcome of the present war, unless indeed, civilized nations should come to the agreement that all lanes of traffic be left unfortified. Such an arrangement is much to be desired in due time. It would involve dismantling the fortresses which now guard the Dardanelles, the Bosporus, the straits of Gibraltar, Aden and Dover, as well as the defenses of the Suez, Panama and Kiel Canals. The more completely force can be separated from commerce, the better for civilization.

In general, most colonial dependencies are held as speculative properties, prospective sources of revenue, or else for the purpose of imperial glorification, which Norman Angell calls "The Mirage of the Map." Most of the great holdings in Asia and Africa come under this last head, yielding no national revenue comparable to the expense of maintenance, and serving to enrich individual traders or exploiters while the burden of empire is borne by the people at home.

In the British Empire the name of "Crown Colonies" is given to those districts administered directly in the name of the king. Colonies of this type exhibit great differences among themselves, but they agree, however, in certain details. Each consists primarily of a great body of native

people, to which sometimes is added a staff of working *peons* from some other region—in plain language, imported serfs or slaves. The upper stratum consists of a relatively small group of traders, exploiters, miners, missionaries and officials, civil and military, engaged, for well or ill, in developing the resources of the country. Such colonies have been obtained in all sorts of ways, by purchase, by friendly negotiation, by reprisal, by wanton invasion and incidental conquest. An invasion of any kind produces disorder, disorder demands the presence of troops, occupation must be permanent to keep order, and the final result in annexation under the general plea of "manifest destiny," or the needs of empire.[7]

At present, the last frontier is reached and every part of the world is under the actual or nominal supervision of some one of the great nations or world-powers. It is evident that no further changes can be made except by force of arms, by friendly negotiations or by efforts for freedom, peaceful or otherwise, from within. It is also evident that most of these colonies contribute to the expense as well as to the glory of the nation in occupation. They may be sources of revenue to individuals, but very rarely to the state. And the actual welfare of these regions is dependent on the acceptance of Article 3, which provides for the "Open Door," that is, absolute freedom of commerce or at least equal liberty of trade to all nations. A pernicious feature of foreign occupancy is the establishment of "spheres of interest," to the detriment of the nation in which they are delimited, and too often conflicting with one another.

So far as the present war is concerned, only the colonies of Germany are brought into question. Practically all of these have been seized by Great Britain during the war, a natural result of her control of the sea.

It will be quite impracticable to hold a *plébiscite* in these captured colonies to determine their future allegiance. For example, in German Samoa (Upolu) there exists a large body of natives numbering some thousands, a few dozen white people comprising German officials and

[7] Referring to the occupation of Chitral in northern India by the British in 1895, Lord Morley thus describes the five stages of the road of "high Empire":

"First you push into territories where you have no business to be, and where you had promised not to go; secondly, your intrusion provokes resentment, and, in these wild countries, resentment means resistance; thirdly, you instantly cry out that the people are rebellious and that their act is rebellion (this in spite of your own assurance that you have no intention of setting up a permanent sovereignty over them); fourthly, you send a force to stamp out the rebellion; and fifthly, having spread bloodshed, confusion and anarchy, you declare with uplifted hands to the heavens that moral reasons force you to stay, for if you were to leave, this territory would be left in a condition which no civilized power could contemplate with equanimity or composure. These are the five stages in the Forward Rake's Progress."

traders, an American hotel-keeper and trader, an American private banker or money-lender, two or three British lawyers, and finally a group of planters owning the cocoanut groves, most of these latter being naturalized German-Australians resident at Sydney. For the rest a few hundred serfs, negroids, brought from the Solomon islands.

A similar problem existed in Hawaii at the time of its annexation to the United States in 1900. The population of American or of North European descent, numbering about 12,000, owned and ruled the island, having overturned the native queen some years before and established a nominal republic. The native Hawaiians numbered about 35,000. There were also about 20,000 Portuguese. Largely in a state of semi-servitude as laborers on the sugar plantations were about 60,000 Japanese and 25,000 Chinese, besides Coreans and Polynesians. Under a *plébiscite* the Hawaiians would mostly have opposed annexation. The Europeans generally favored it, but the final decision could hardly have been left to the illiterate majority on the plantations.

We must therefore fall back on the simple denial of the right of conquest even of colonial dependencies. The German colonies seized during the war should revert, unless, as a result of negotiation, some friendly exchanges can be made. Some such readjustments might seem to be possible and desirable.

It is certainly not wise to deprive a nation which has its heart set on colonial control of all opportunity to experiment with it. Colonial experience on a large scale tends to reduce the pressure of militarism at home, though at the same time expanding the demands of the military group. In time also it teaches the art of administration, which is apparently to be learned mainly through failure. The ultimate lesson seems to be that the only cement which really binds an empire together is the bond of freedom. Government which rests on force alone becomes ultimately brutal. This saying is credited to Cavour:

> We can do anything with bayonets except to sit on them.

Provision might be made in international law for some form of condemnation of territory needed for purposes of civilization and held by recalcitrant tribes. But such right of condemnation should not be assumed by a powerful nation as against a weaker one. If necessity exists at all, it is a sort of community interest, in which any action taken should be a joint enterprise of the nations concerned. The position of the United States in regard to the Canal Zone in Panama would have been stronger if the approval of the great states of South America had been secured before action was taken.

In some of the more difficult of the problems involved in the adjustment to follow the war (those concerning Constantinople, Macedonia, Armenia, Mesopotamia, Syria, Persia, the Congo) it may be found

profitable or necessary to form international commissions of control. These would have their difficulties, but the purpose being fair play, the embarrassments would be relatively unimportant. The main thing is that modern methods of open conference should supersede traditional diplomacy.

V. Conclusion

We may now amplify Article I.

No right of conquest shall be recognized and no military necessity to the prejudice of neutral people or of neutral nations. No annexation or transfer of territory shall be made by force as a result of war or conquest. In case a problem of transfer of allegiance should concern a homogeneous civilized district accustomed to self-government by plébiscite, no transfer shall be made except in accordance with the will of the people, expressed in the secret ballot and without duress, the basis of suffrage being that already recognized in such region, preferably "one man, one vote." Whether any given district or province shall vote as a whole or by smaller units must depend on the actual conditions in the region concerned.

To the above we may add certain allied propositions. All extortions of indemnities by force of arms must be condemned as of the moral status of highway robbery.

Democratic control of foreign policy, involving the right of every people to keep out of war, would be a powerful influence towards international stability. Its logical outcome would be the abolition of a system of military conscription which has made an armed camp of the continent of Europe. All use of military intimidation as a political argument is fundamentally wrong because opposed to security and progress. Science is human experience tested and set in order. Science decries every influence which works adversely to human welfare, impairing abundance of life.

In so far as the propositions here set forth are sound, they represent "positive law" as defined by Grotius, that sequence of cause and effect which is inherent in the nature of human relations and which forms the solid basis of International Law. "Voluntary Law," whether the result of democratic agreement of the people or diplomatic deals of autocratic rulers, can never attain equal solidity or have equal binding force.

Finally, the success of any plan for durable peace must rest on the acceptance in good faith of Article 9 of the "Minimum Program." This provides for the abolition of secret treaties, with the permanent elimination of tortuous wrangling diplomacy and methods of medievalism.

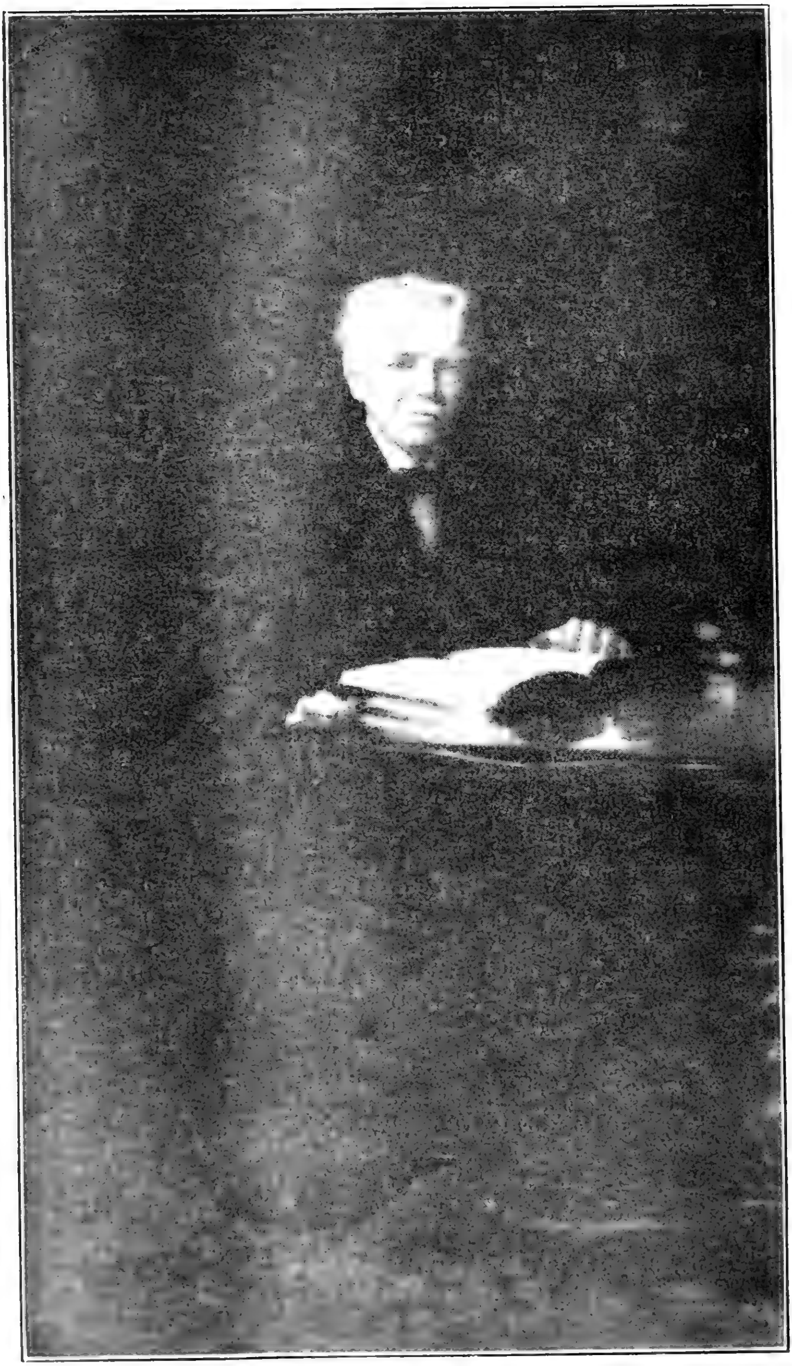
THE PROGRESS OF SCIENCE

THE NEGLECT OF SCIENCE IN GREAT BRITAIN

A NUMBER of leading British men of science have united in signing a memorial protesting against the national neglect of science. They include Lord Rayleigh, Sir William Crookes, Sir William Ramsay, Sir William Osler and thirty-two others whose names carry great weight. The memorial urges that Great Britain has suffered checks since the war began, due directly as well as indirectly to lack of knowledge on the part of legislators and administrative officials of the ascertained facts and principles of science. Not only the highest ministers of state are ignorant of science, but the same defect runs through almost all the departments of the civil service; it is nearly universal in the House of Commons and is shared by the general public, including a large proportion of those engaged in industrial and commercial enterprises. The only exceptions are the navy and the medical service of the army, in which results have been achieved by men who have had a scientific training.

It is said that success now and in the difficult time of reorganizing after the war depends largely on the possession by leaders and administrators of scientific method and the scientific habit of mind. They must have knowledge and the habit of promptly applying known means to known needs. This can only be effected by a great change in the education of the class from which officials are drawn. The education of the democracy would follow a change in the education of the wealthy classes. It is pointed out that at present the methods of the old vested interests have retained their dominance at least as far as the ancient universities and the great schools are concerned. At Cambridge, but four colleges are presided over by men of scientific training, at Oxford, not one. Of the thirty-five largest and best-known public schools, thirty-four have classical men as masters, none has a scientific man. The examinations for entrance into Oxford and Cambridge and for appointments in the civil service and in the army are such as to encourage the neglect of the study of the natural sciences and to some extent to encourage an indifferent not to say a contemptuous attitude towards them. The memorial urges the electors to insist that candidates for their suffrages should pledge themselves to aid by legislation in bringing about a drastic reform in the scheme for examinations in all the public services, a reform which it is claimed is vital to the continued existence of Great Britain as a great power.

A scientific man used to dealing with things as they are is probably a better legislator or administrator than a lawyer used to dealing in words and tradition. But expertness in science does not make a man omniscient or always wise in other directions. To take a trivial example, these thirty-six distinguished men of science blame a member of the government for not knowing that glycerine can be obtained from lard, but in the preceding paragraph they say that Lord Playfair is the only trained man of science who has been a cabinet minister, whereas he never was a cabinet minister. Sir William Crookes's opinion as to ghosts is not valuable. Sir William Ramsay doubtless regards Professor Ostwald's views on the conduct of the war as extremely foolish, and Professor Ostwald in turn doubtless looks on Sir William Ramsay's publications regarding the permanent sub-



PROFESSOR JOSIAH ROYCE, THE LATE PROFESSOR WILLIAM JAMES AND PROFESSOR GEORGE HERBERT PALMER. This painting of the three distinguished professors of philosophy of Harvard University by Mrs. Winifred Ruber will probably be purchased

by a group of alumni for presentation to the university. Professor Royce is seated on the left; Professor James is seated on the right; Professor Palmer is standing.

jection of Germany is beyond measure absurd.

There is no reason to suppose that the study of the classical languages is carried to excess in the United States, though a great deal of time is doubtless wasted in our schools on the elements of languages which are never learned or used. The classical curriculum dominates the German gymnasium more completely than it does the English public school. The number of people who can read Latin in Germany is far greater than the number in England, but in equal measure the number trained for research work in science is greater. According to Professor Vignon, of Lyons, there are for each 1,000 chemists in Germany 28 in France and 24 in England. What both Great Britain and the United States can learn from Germany is not so much substituting one kind of memory work for another in the schools and in civil service examinations, as the appreciation of the supreme value of research and the importance of depending on the expert in the field in which he is competent.

RECENT EXPERIMENTS IN AERODYNAMICS

The Smithsonian Institution has just issued and sends us an abstract of an illustrated pamphlet containing a series of technical reports on experiments recently conducted in the wind tunnel for aerodynamics at the Massachusetts Institute of Technology, at Boston, Mass.

In writing on this wind tunnel itself, J. C. Hunsaker, assistant naval constructor, U. S. N., and instructor of aeronautics at the Institute, says that since it is difficult to carry on full scale experiments to investigate the aerodynamical characteristics of a proposed air-craft design, tests are made on small models, as in naval architecture. The experiments are further simplified by holding the models stationary in an artificial current of air with a maximum wind speed from 34 to 40 miles an hour, instead of towing them at high speeds through still air to simulate actual flying conditions.

After a study of the principal aerodynamical laboratories of Europe, it was decided to reproduce at Boston the four-foot diameter wind tunnel of the National Physical Laboratory of Teddington, England, together with the aerodynamical balance and instruments used there for measuring velocity. In this connection the director of the English laboratory generously presented the detailed plans of the complete installation to the Masachusetts Institute of Technology. Mr. Hunsaker describes the wind tunnel, the aerodynamical balance, and explains some of the experiments and principles involved

The second article of the series comprises notes on the dimensional theory of wind tunnel experiments, by Edgar Buckingham, of the U. S. Bureau of Standards, who defines the theories and principles involved, and suggests standardization of the methods employed.

In another report Mr. Hunsaker discusses the most common and convenient form of pressure anemometer, known as the Pitot tube, an instrument used in calculating the wind velocity from the pressure differences. He also describes the construction of an inclined manometer, a form of pressure gauge, used in the experiments.

Messrs. H. E. Rossell and D. W. Douglas report on their experiments concerning the adjustment of the velocity gradient across a section of the tunnel. Since in wind tunnel experiments it is essential that the velocity of the air striking different parts of the model under test, shall be the same, it was necessary after developing precise methods for measuring the velocity, to explore the cross-section of the tunnel to detect variations in velocity from point to point. The results of their experiments and the effects secured by the adjustment of a honeycomb grating, which straightened out the flow of air, are recorded.

Tests of the characteristic curves for

wing sections are discussed by Messrs. H. E. Rossell, C. L. Brand, and D. W. Douglas. They experimented with and tested the aerodynamical constants published by the British Advisory Committee for Aeronautics for wing profile R.A.F. 6, and found the results to be sufficiently precise for purposes of aeroplane design.

J. C. Hunsaker discusses stability of steering of a dirigible, citing some of his experimental tests with a wooden model of a dirigible hull fitted with rudders and fins in accordance with regular practice. It is now possible to base the design of fin and rudder area upon his data instead of "rule of thumb." His experiments proved that with the size rudder and fin fitted (7.79 and 3.47 sq. inches), the ship could be held on its course by the use of not more than 16½ degrees of rudder. The importance of a vertical rudder was proved, but it was found impossible in practice to give sufficient vertical fin area to hold the ship on its course without the use of the helm.

The pitching and yawing moments on a model of a Curtiss aeroplane chassis and fuselage, complete with tail and rudder, but without wings, struts or propeller are set forth in an article by Messrs. Hunsaker and Douglas. Swept back wings are discussed by Messrs. Rossell and Brand, who maintain that with a sweep back of ten degrees an appreciable righting moment may be expected without change in any of the other aerodynamical properties of the straight wing.

In order to ascertain whether the righting moment secured by swept back wings as investigated by Messrs. Rossell and Brand, could be better obtained by another method, Messrs. Hunsaker and Douglas experimented with dihedral angle wings. They maintain that the didehral angle wings afford better results than the swept back wings, and since the former are built much more easily, it is believed that the dihedral is of more value for purposes of lateral stability. Attention is called to the fact that the "Langley aerodromes" built by the late Secretary of the Smithsonian Institution, were equipped with dihedral angle wings inclined upwards about six degrees. The last article is by J. C. Hunsaker and deals with critical speeds for flat discs in normal wind.

LONG-RANGE WEATHER FORECASTS

The chief of the U. S. Weather Bureau has sent us a statement to the effect that in the opinion of the bureau a new system of long-range weather forecasting, which has been widely discussed recently, is quite fallacious. The new system is said to be based on the spottedness of the sun and rifts and shafts of solar radiation. In the opinion of the Weather Bureau it belongs in the same class with other methods of long-range weather forecasting based on lunar, planetary, magnetic and astrological considerations. None of these systems has any scientific value.

During the past few years the Weather Bureau has received full specifications concerning all the essential details of this particular system. The alleged discovery is, therefore, fully known to the Weather Bureau and has been carefully studied and examined by its scientific staff. Moreover, other scientific men of international reputation now connected with the strongest institutions of the world engaged in astronomical research, and conducting investigations into solar and terrestrial physics, have also passed upon these new theories. These authorities are in accord that the deductions and conclusions drawn from the solar conditions on which the new system is based are unwarranted.

When the disk of the sun is minutely examined with powerful telescopes, or when it is photographed with the aid of the modern spectroheliograph, the surface presents a characteristic spotted appearance which undergoes slight changes from day to day, and greater

changes with longer intervals of time, depending upon the well-known rotation of the sun upon its axis and the periodic recurrence of the sunspot maxima and minima. These and certain well-known related phenomena are now put forward as the basis of a new science which will make possible forecasts of the weather far in advance. That these features of solar activity, however, actually should control and determine the daily changes and sequence of weather conditions in any definite or direct and consequential manner, is quite impossible. Solar phenomena of the kind described do not have any direct influence upon the weather at any particular time and place, and can not be made the basis of any forecasts whatsoever.

The alleged discovery is only one of a number of similar schemes which are continually being put forward. In some cases the advocates assert that they can forecast the weather for weeks or months in advance, and in others they state that they have found means of producing rain artificially, of preventing hail, and in other ways of interfering with and controlling atmospheric phenomena. These pretensions meet with a certain credence because there are a number of people who still cling to the ancient belief in the influence of the moon on the growth and development of crops, and to the idea that the weather conditions depend upon planetary and astrological combinations. In consequence the Weather Bureau has been called upon from time to time to caution the general public against putting faith in these so-called discoveries.

The U. S. Weather Bureau is the authorized agency of the government to collect meteorological observations and make and issue weather forecasts and warnings. Every important nation of the world has a similar organization and all use essentially the same methods. All these organizations condemn and disprove the methods and theories of those who assert that they are able to predict the weather for any considerable period in advance.

SCIENTIFIC ITEMS

We record with regret the death of Dr. Harry Clary Jones, professor of physical chemistry in the Johns Hopkins University; of Theodore Pergande, of the Bureau of Entomology; of Wells Woodbridge Cooke, of the Biological Survey; of John Wesley Judd, formerly professor of geology and dean of the Royal College of Science, London, and of Ernst Mach, emeritus professor of the history and theory of inductive science at Vienna.

Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, gave the William Ellery Hale Lectures at the meeting of the National Academy of Sciences in April. The subject was "The Origin and Evolution of Life on the Earth."—Dr. George Sarton, who is now lecturing in the United States on the history of science, the former editor of *Isis*, an international review devoted to the philosophy and history of science, published in Belgium, but discontinued during the war, has been awarded the Prix Binoux by the Paris Academy of Sciences.

Appropriations amounting to $1,200,000 have recently been made by the Rockefeller Foundation. To the Rockefeller Institute for Medical Research is given $1,000,000 for additional endowment needed in connection with the Department of Animal Pathology, recently established near Princeton, N. J. To the Rockefeller Institute for Medical Research, $25,000 goes for the cost of medical work at the seat of war in Europe. Most of this appropriation will be used for the support of the research and hospital work being conducted by Dr. Alexis Carrel in France. The China Medical Board receives $125,000 for the purchase of additional property adjoining the Union Medical College in Pekin. The international committee of the Young Men's Christian Association receives $50,000 in support of the work in the military prison camps of Europe.

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THE OLDEST PLACE OF WORSHIP IN THE WORLD[1]

BY WALTER K. FISHER
STANFORD UNIVERSITY, CALIFORNIA

TAI Shan in central Shantung is the most noteworthy of the five sacred mountains of China and is the oldest place of uninterrupted worship in the world. In the remotest mythical period kings made regular sacrifices on the mountain top, the nearest approach to heaven known to them, and this practice continued into the eleventh century of the Christian Era. To-day a temple marks this primeval altar, and the infrequent foreigner may carelessly stand on the rocks where Yao and Shun, heroes of China's "Golden Age," made their offering to the Spirit of Heaven. In the earliest mention of the mountain, about 2,000 B.C., and probably long after it had become an object of religious regard, we find the worship described as being, not of the mountain, nor of a spirit abiding there, but of one God, a dweller in heaven. Yet from time immemorial the people have personified the mountain or imagined that it has a soul, or is inhabited by a spirit, which is alluded to as the genius of the mountain. This has been given names, which have changed in different epochs. In 1369 the Buddhist founder of the Ming Dynasty decreed that worship should be offered to Tung Yo T'ai Shan. When Taoist influence becomes predominant, Tai Shan has a birthday, and is the abode of a multitude of spirits, and has to do with the birth, death, adversity and prosperity of mortals, while the little hill of Kao Li at its foot is closely associated with the judgment of human souls after death. In the sixth, seventh, tenth and twelfth centuries the Buddhists were in control, but now their presence is scarcely noticeable. The temples have fallen into the hands of illiterate Taoist priests who seem to foster the worship of the "Lady of Tai Shan" rather than of the mountain itself. The legends of the "Jade Lady," as she was at first called, are very indefinite. She has been seen twice, first in 2600 B.C., and again about A.D. 65, as one of seven women, dressed in feathers and crowned with clouds. A more popular tale identifies her with a girl named Yu Yeh, born near Tai Shan in the year 143 B.C., who at a tender age went to live in a cave on the mountain, hoping to

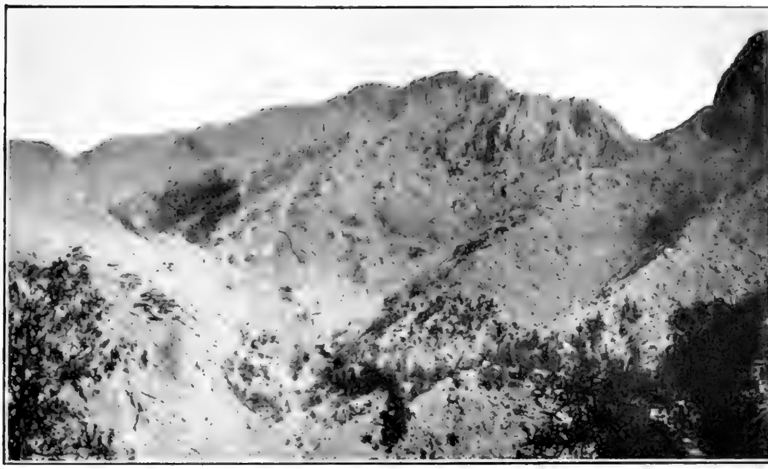
[1] Photographs by the author.

Tai Shan (Great Mountain) from Near the Beginning of the Pilgrims' Way, which is shown on the left. The "Eighteen Flights" leading to the Heaven Gate can be seen below the notch some distance to the left of the peak. Note the gardens in the ravine.

become a fairy. After three years she is said to have attained her object. About 1008 a marble statue of the Lady was found in the Pool of the Jade Lady on the mountain-top, and this discovery seems to be responsible for her present popularity. The chapel in which this statue was placed preceded the present Lady Temple, the chief shrine at the summit. Aside from its local features, the religious fortunes of the mountain have followed those of China as a whole.

The annual pilgrimage is the most characteristic feature of the worship. The shrines are thronged with pilgrims during the first three or four months of the year. In former times they attended in hundreds of thousands, even millions, from all over the empire, but now the numbers have greatly fallen off and few come from beyond the province. The pilgrimage is the occasion of a fair in the walled town of Tai An at the south base of the mountain. Here the large Lady Temple is filled with shops of all sorts, and in the open spaces outside are refreshment venders, quacks, peep-shows, minstrels, and story-tellers. The pilgrims travel very frequently in clubs. Each member contributes a monthly subscription to the promoters until a sufficient sum has been collected. Then in the first moon (February) they set out, usually afoot, the leader carrying a flag with the name of their town and other items written upon it, while the other members often wear a red or yellow girdle. Their money is spent first on religious duties, secondly on food, fairs, gambling, and lastly in some cases on erecting a stone tablet to commemorate the names and subscriptions of the participants.

Prior to the completion of the Tienstsin-Pukow railroad it was diffi-



TAI SHAN FROM BEYOND THE HALF-WAY STATION: Heaven Gate and the steps leading to it on the left. The two conspicuous squares on the face of the cliff are inscriptions left by former pilgrims. Compare with neighboring pine tree. In the foreground the Pilgrims' Way is on the right.

cult for a foreigner to reach Tai Shan. Now the journey is a long day by train from Tientsin to a small station called Taianfu, two miles west of the walled town of Tai An, which crouches at the south base of the mountain, and from which the remarkable Pilgrims' Way sets out. Be it remembered the railroad has not brought the English language, nor the foreign hotel. Except for the trains, this part of the ancient kingdom of Lu has changed little since the days of Confucius.[2]

We quitted Taianfu in the chill of an October dawn, borne in mountain chairs by sturdy Shantung men. There were four of these chairs,[3] each carried by two men, while four extra bearers followed the caravan to relieve the others. We made a brave showing as the coolies pattered over the rough plain toward approaching day. Tai Shan looked all of its 5,000 feet. Its gaunt head and shoulders were chang-

[2] Without the aid of Mr. P. H. Henry Sze of the Tientsin-Pukow railroad, who generously acted as cicerone and supplied a comfortable private car, two American wanderers would never have beheld the cliffs of gray Tai Shan. The language alone is a sufficient barrier to a foreigner, while it requires a considerable outfit to utilize a Chinese native inn. To the Honorable Alfred Sze I am equally indebted for having suggested the pilgrimage, and for having aided in its accomplishment.

[3] These chairs consist of a square frame with a few cords stretched over it for seat, and fitted with a foot board and a low back. Two curved carrying poles are fixed to the frame with iron clamps, and are slung by long leather straps and cords over the shoulders of the bearers, who often hold the ends of the poles in their hands. In going up or down the steep mountain path, or sometimes also on level ground, the bearers walk abreast, with the occupant facing sideways between them. A third man may aid the others.

THE UPPER PART OF THE PILGRIMS' WAY, showing the Eighteen Flights and the South Gate of Heaven. The road here follows the margin of a dry torrent bed. Note the people on the road.

ing to a rosy image of the erstwhile uncompromising crags, while broad masses of shadow still clung to its uncertain boulder-strewn flanks and ravines. Greeted by dogs, we flitted past Tai An, up the broad Pilgrims' Way where so many of the lowly and great of China had preceded us. This road, ten feet in width, paved with rock and often bordered by substantial walls, clambers up ravines, over ornate bridges, meanders through venerable cypress groves,[4] jumps over ledges in

[4] Although called cypresses these trees are really large *Thuya orientalis*.

THE TAI SHAN CHAIR.

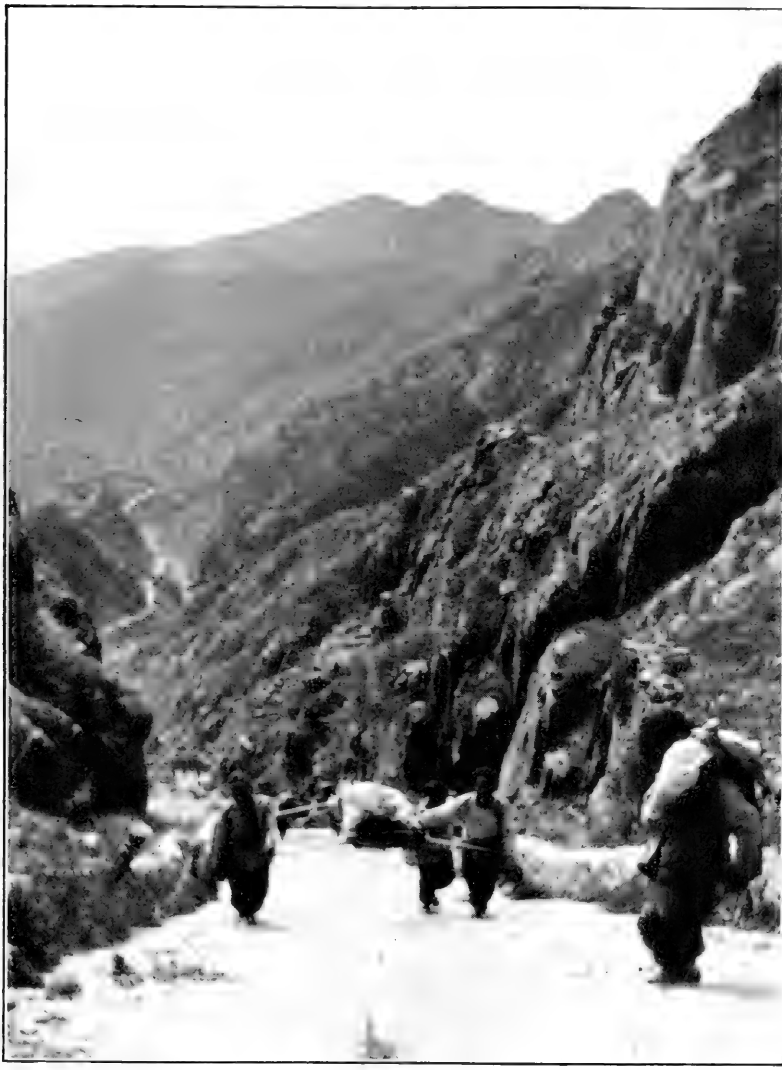
flights of steps and with a trajectory like that of a sky-rocket scales the last steep gorge and disappears through the South Gate of Heaven, nearly five miles from Tai An.

With the coming of the sun a multitude of beggars crept from near-by hamlets and demanded coppers in whining tones. Above a zone of small temples, overshadowed by ash-like huai trees, we came upon huge boulders underneath which had been constructed little cells

"THE BEARERS STOPPED FOR BREAKFAST AT A SORT OF LITTLE HALF-WAY STATION, where over acrid fires of cow-dung they brewed tea and devoured huge cakes resembling hardtacks, twenty inches in diameter."

THE SOUTH GATE OF HEAVEN (NAN T'IEN MEN). This great gate marks the entrance to the sacred precincts of the summit and is at the top of the Shih Pa Pan or Eighteen Flights. Beyond it are all the temples of the mountain-top, and a small village of thatched stone huts which line a continuation of the Way, leading to the Lady Temple. Note the chain on the left placed there to aid weary pilgrims.

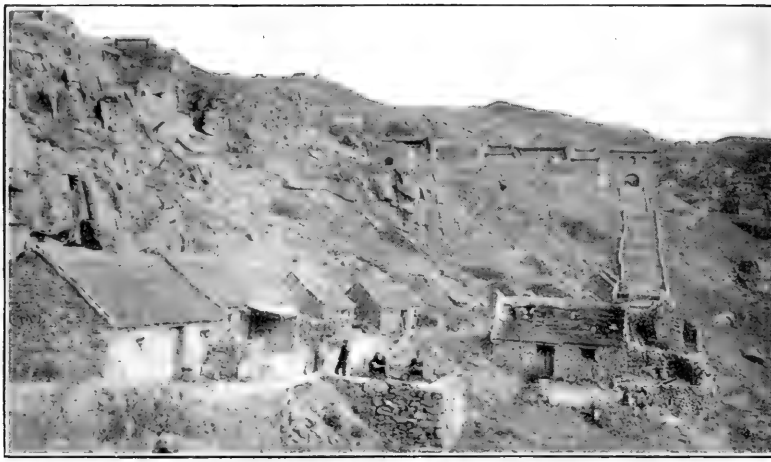
in which beggars or perhaps holy folk live when the way is thronged with devotees. On the stony sides of the ravine were little garden patches, with here and there a mud-and-stone walled house. Magpies called from the cypress-clad slopes, and an occasional Chinese blue-pie stopped on a wall to inspect us. Among the numerous honorary gateways or pailows, we passed under one characteristically Chinese, for growing out of the front were two fairly large cypresses. Weeds,



THE PILGRIMS' WAY, FROM THE GATE OF HEAVEN. Looking down the Eighteen Flights, over spurs of Tai Shan. This is the steepest part of the "road," which for many hundreds of feet is a huge flight of stone steps. If one holds the picture horizontally directly below the eyes, the effect of steepness is partly gained.

bushes, and even trees adorn nearly every edifice of sanctity, as well as others of no pretensions.

The bearers stopped for breakfast at a sort of little half-way station, where over acrid fires of dry, peaty, cow-dung they brewed tea in pewter-bound, globular pots of unglazed earthenware, once white but now a meerschaum brown from long use. Fortified with this, they devoured huge cakes resembling hardtacks, twenty inches in diameter. Then



THE TEMPLE OF THE MOUNTAIN LADY. "At the end of a meandering street skirting the verge of some cliffs is the principal Lady Temple, built of stone covered with reddish plaster and roofed with yellow and gray tiles (sometimes of brass or iron)." The steps lead to the west gate (1661). The second roof to the left, that of the Gate Hall, is covered with iron tiles. The main temple is the last large building of this group, to the left. It is roofed with brass or copper tiles. Of the three temples in the upper left corner, the lowest is dedicated to Confucius. Note the thatch held down by sticks and stones.

each drew from a tube at his belt a little pipe which he deftly lit with flint and steel. The flint and tinder (soft Chinese paper rolled into a cylinder and charred at the end) were kept in a small ornamented wallet, the lower side of which had a piece of steel the whole length like the runner of a skate.

On either side of the Pilgrims' Way, deeply chiseled in the rock, are numerous inscriptions, some gigantic in size. They record the visits and thoughts of pilgrims of note. Some are poems, and of many the ideographs are archaic, perhaps antedating the present road itself.

It is pretty certain that the Way follows the course of an extremely ancient trail, yet who built it, or when, is not definitely known. It has been called the P'an Tao or P'an Lu and a book of the Han Dynasty (202 B.C.–A.D. 220) says: "The P'an Tao goes winding upward with over fifty stages (p'an) and the distance from the foot to the ancient altar is 40 li." At that time the great final ascent to the Tien Men, or Heaven Gate, evidently existed. It was called Huan Tao and pilgrims were aided in their climb by ropes. Now, cascading down a wild ravine for many hundreds of feet from the mouth of the Tien Men is the noble Shih Pa Pan (or Eighteen Flights) flanked for the last hundred feet by heavy iron chains. Those who are content to forego the exhilaration of a walk up Tai Shan are at least willing to forsake the mountain chairs on the Shih Pa Pan. Yet the coolies are said never to miss their footing.

Scattered over the bleak mountain-top at several different levels are over half a dozen groups of temples of rather conventional Chinese pattern. The site of the ancient altar on the topmost peak is occupied by a small temple to Yu Huang, a Taoist God, dating from the middle ages. The roof is protected by heavy iron tiles resembling those of clay. The ground is classic, for here in China's Golden Age were offered sacrifices to Heaven, and here many of the great scholars and statesmen of each succeeding dynasty were drawn by reverent curiosity. Confucius climbed Tai Shan and thought the empire small. Beside the steps leading to this altar is the Wu-tsu-pei, or Uninscribed Monument, a granite obelisk fifteen feet high, set up according to tradition by Ch'in Shih H'uang in the third century before Christ. On this part of the mountain are numerous inscriptions and monuments left by pilgrims. A rock called T'an Hai Shih, upon which people stand to watch the sun rise "from the sea," is not far from a cliff, whence numerous fanatics have plunged, hoping to save by their own death the life of a dying relative. A quiet, deserted-looking temple contains the sleeping image of the Mountain Lady, a figure which is dressed and undressed, put to bed and got up like a doll. Another temple partly hides a colossal monument in the form of an inscribed tablet cut in the face of a cliff. It is thirty feet high and sixteen feet wide. The characters were chiseled in 726 A.D. but are still clear after twelve centuries' exposure to the elements.

Below these temples and at the end of a meandering street skirting the verge of some cliffs is the Pi Hsia Ts'u or principal Lady Temple, built

THE TEMPLES SURROUNDING THE ANCIENT ALTAR ON THE SUMMIT OF TAI SHAN, dedicated to Yu Huang and dating from the middle ages. The altar is a knob of bare rock surrounded by a stone fence in a central courtyard. The "Uninscribed Monument" is seen beside the steps. It was erected in the third century before Christ.

THE LADY TEMPLE. A portion of the front, and the main court. In the huge incense-burner in the foreground we sacrificed a few bushels of paper temple money. Within the temple is an image of the Lady of the Mountain, along with other Taoist deities. The tiles are of copper.

of stone covered with reddish plaster and roofed with yellow and gray tiles. It is reached by flights of steps, which lead to a terrace, thence to the great Gate Hall, opening upon the main court, the north side of which is occupied by the main Hall of the temple. Within, the chief images are those of the Lady and of the deities presiding over childbirth and eyes. In this court are some old bronze incense burners, in one of which we sacrificed a quantity of temple money, purchased from a priest. This offering consisted of large disks of red and gilt paper,

somewhat resembling a Chinese kite. Properly burnt with incense it is much appreciated by the Lady of the Mountain, who has no use for the coin of the realm. In a side chapel is a very ancient stone, with traces of archaic inscriptions. It is much cracked and is propped together by stones. But in these temples, as elsewhere in China, the visitor without the language of the country is practically lost. Information from the priests is vague and unrelated. The traveler must piece together the disconnected bits by a vast amount of surmise, and restrain his curiosity until he can "read up," perhaps a year later when he reaches home.

This Pi Hsia Tz'u is the most wealthy of the shrines on Tai Shan and owes its origin to the discovery of the Lady's image in the Pool of the Jade Lady. The first temple was built in 1008. It was rebuilt on an elaborate scale in 1585, but was destroyed by fire in 1740 and reconstructed with considerable change in 1770.

Bordering the road which winds around the south face of the mountain from the Heaven Gate to the Lady Temple are picturesque stone huts, the roof thatch bound tight against the winter winds by strips of cane or bamboo. On the opposite side of the way, next to the wall above the bluffs, are massive stone tables between stone trenches, the tables marked into squares for some game like chess. Within, the cottages are smoked to a shiny blackness by the dung fires and streamers of soot are pendant from the dusky region of the thatch. They are occupied mostly by old people, two of whom hospitably gave me hot tea and took a childish delight in my interest in their simple belongings. The fire is made in a raised stone hearth, in the top of which are several apertures for the accommodation of iron saucepans and pewter kettles. The water flasks, lamps, dippers, and tea-pots are all of excellent design. The tea-pots are of earthenware, with pewter handle and spout, and stained a rich brown by long use. Silver would not tempt the old man shown holding temple money to part with his, for he told Mr. Sze it had been in the family for five generations and was very precious to him. The interiors are all very simple. Besides the raised hearth, there is a large earthenware water jar near the door, sometimes a rude table, and at one or both ends of the room a broad raised platform of coarse matting or basket-work which serves as a bed and a settee. When the door is closed there is little light. These dwellers within Heaven's Gate lead a life primitive in the extreme, and the rigors of winter must be severe on the old folks, unless perchance they all migrate to the plains.

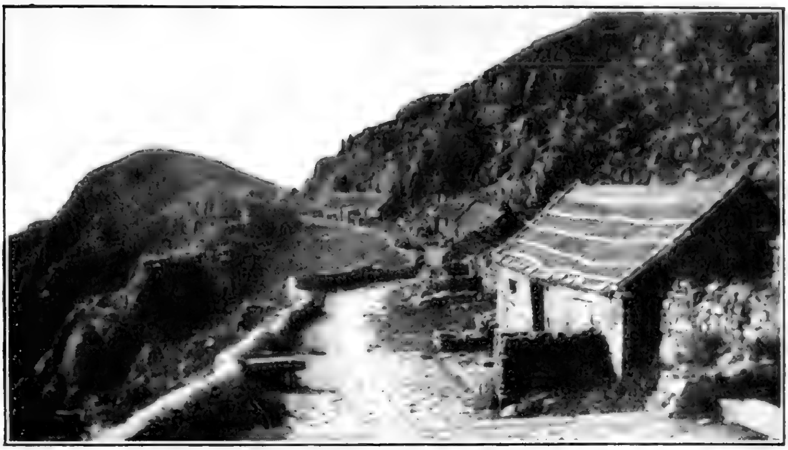
Finally, what is Taoism? It is commonly supposed to be the philosophy of Lao-tsze who, between 500 and 600 B.C., wrote the Tao Teh King. In practice it is no such thing. Lao-tsze taught the Tao, or the "Way," concerning himself, as did Confucius, his contemporary, with ethical principles, the conduct of the individual and of society, and not at all with religion. The Tao was "the simplicity of spontaneity,

ONE OF THE NUMEROUS INSCRIBED ROCKS ON THE TOP OF TAI SHAN.

action without motive, free from all selfish purpose resting in nothing but its own accomplishment." This is found in the phenomena of the material world.

> All things spring up without a word spoken, and grow without a claim for their production. They go through their processes without any display of pride in them; and the results are realized without any assumption of ownership. It is to the absence of such assumption that the results and their processes do not disappear (Chap. II.).

He applied this principle to the government of society and the individual. His teaching reaches its highest levels in the following:



DWELLINGS WITHIN THE GATE OF HEAVEN. "Bordering the road which winds around the south face of the mountain from the Heaven Gate to the Lady Temple are picturesque stone huts, the roof thatch bound tight against the winter winds by strips of cane or bamboo." This village is called the T'ien Chieh, and the picture is from the foot of the steps leading to the Lady Temple.

It is the way of Tao not to act from any personal motive, to conduct affairs without feeling the trouble of them, to taste without being aware of the flavor, to account the great as the small and the small as the great, to recompense injury with kindness.

There is scarcely a word of Lao-tsze which savors of superstition or religion. Taoism to-day is a system of abject superstition. It did not take shape for more than 500 years after the death of Lao-tsze.

INTERIOR OF A TAI SHAN HUT. To the left is the stone stove with cooking utensils and, beyond, a table. On the right is a large water jar in front of a table set "for tea." The old men are sitting on one of the bed platforms; the photograph was taken from the other. There is a broom leaning against the stove.

OLD MAN WITH TEMPLE MONEY. This old man sells temple money to be burned at the altar of the Lady of the Mountain. It is made of red and gilt paper. Note the quilted coat and trousers and the fur cap with ear flaps.

In the first century A.D. a magician Chang Tao-ling is the chief professor and controller of this Taoism, preparing in retirement the pill which renewed his youth, supreme over all spirits, and destroying millions of demons by a stroke of his pencil.

It was not until about A.D. 70 that the system borrowed temples, monasteries, liturgies and forms of public worship from the Buddhists and set up business as a religion. After assuming the form of a religion it continued to degenerate until now it is "in reality a conglomeration of base and dangerous superstitions" fused with a system of the wildest

polytheism. Alchemy, geomancy, spiritualism and black art generally flourish under its shadow. Each of its three Holy Ones (of whom Lao-tsze is one) has the title of Tien Tsun, "The Heavenly or Honored," taken from Buddhism, and also of Shang Ti, or God, taken from the ancient religion of the country. To the myriad of other demigods and spirits are added many of merely local import, as the Lady of Tai Shan.

As one looks from Heaven's Gate, down the long Pilgrims' Way and into the golden haze that lingers over the Cradle of China, he seems to conjure up that solemn procession of people and kings of old Cathay, stretching in an unending line to the dim legendary realm of a heroic age. Dynasties have risen and died, yet the innumerable multitude with each recurring spring has been drawn hither as by a titanic lodestone. Each has had his own quest, and, doubtless, in spite of the trumpery of childish superstition, many now find solace on the mountain top. Yet while blindly following the Pilgrims' Road has not the great host wandered far from the "Way" which was blazed for them in the braver, saner days of old?

THE EVOLUTION OF THE EARTH[1]

II. Earth-Growth

By Professor THOMAS CHROWDER CHAMBERLIN
THE UNIVERSITY OF CHICAGO

IN the view that was dominant during the last century—perhaps dominant still—the earth, when it had emerged from its natal conditions and had become a mature planet, was pictured as a molten globe surrounded by an atmosphere embracing all such earth-substance as would be volatile at the temperature of white-hot lava. The earth must then have been a perfect sphere, except as rotation imposed a symmetrical deformation upon it, and even the details of its surface configuration scarcely departed from the contours of a perfect spheroid. Its internal structure must have been symmetrical, the denser material at the center, the less dense in concentric layers about this, the least dense at the surface. Each layer should have been essentially homogeneous in itself. The stresses within the earth, at first, must have been purely hydrostatic, increasing necessarily from the surface to the center.

The evolution of the earth under this concept was actuated by changes of energy within the hot young planet itself, chiefly loss of energy by radiation. At an early stage of this loss, a crust formed over the uniform surface of the symmetrical spheroid, dividing the fluids below from the fluids above. On this crust, the vapors descended, and a universal ocean followed; and then—if we pursue the picture so impressively painted by the old masters in geology—there was a prolonged battle between fire and water, the ocean penetrating to the hot material beneath it and arousing explosive action of a spectacular sort. Lateral thrusts arose from the shrinkage of the cooling globe, followed by bowings, foldings and fractures. Here and there, the crust emerged from the universal ocean and the great contest between the sea and the land was initiated. Thus the postulated evolution was made to arise in simplicity and to go forward in a symmetrical, logical way. It was pictured with great impressiveness—not infrequently with a touch of eloquence, often with a touch of poetry—by the masters of geology in the middle of the last century.

We owe these old masters a tribute of gratitude for the clear views

[1] Third series of lectures on the William Ellery Hale foundation, National Academy of Sciences, delivered at the meeting of the Academy at Washington, on April 19–21, 1915.

they set forth, and for the logical fidelity with which they followed the premises they adopted, a fidelity largely lost in these later years, by the adherents of the same cosmogonic tenets. This lapse is not without reason, for the later students of the earth have been compelled to accommodate their views to new disclosures of stubborn realities that do not fall into obvious accord with the cosmogonic antecedents so sharply postulated in the earlier years. It is perhaps not far from the truth to say that, in recent years, few geologists have tried to follow rigorously the cosmogonic tenets handed down to them. Usually they have contented themselves with shaping their views to fit the more specific aspects of the phenomena they have had immediately under consideration. A multitude of divergencies from the simple tenets of our forefathers have thus arisen and have come to penetrate modern geologic literature in a most intricate way. The stubbornness of the realities revealed by progressive inquiry has amply justified a swerving from inherited tenets. It has equally invited a loosening of the hold of doctrines that depend on these tenets. In recent years the insubordination of new determinations to old interpretations has risen to declared refractoriness. The old problem of the origin of the continental embossments and the abysmal basins, the problem that lies at the very threshold of earth science—always a troublesome problem, because of the great range of the inequalities—has lately assumed a new form and become a burning question of the hour. Under the stress of time-limits, let us take this as a type of a large class of new issues. I refer to the fundamental question that lies beneath the growing doctrine of isostasy, the origin of the differentiation of specific gravities deep in the crust of the earth necessary to actuate isostatic movement, the very basis of isostasy. In this lies a grave challenge of the molten concept of the primitive earth. Very cogent reasons have been adduced from geodetic data, particularly by Hayford and Bowen, for the belief that the protrusions of the continents are in isostatic balance with the depressed segments beneath the oceans. It is hence inferred that the material beneath the continents is as much lighter than that beneath the oceans, as the former are protrusive and the latter depressive; in other words, the difference in the specific gravity of the rock columns beneath the continents and beneath the oceans, respectively, must extend far enough down to compensate for their differences of height. A great mass of refined observations support the isostatic view, at least in its major features.

But from the earliest days of geologic record, the atmosphere and the hydrosphere have been persistently cutting away material from the continents and depositing it in the basins, while the continents have been pushed up, at repeated intervals, and the denudation renewed, else the sea would long since have crept over the whole land. Many thousands of feet have been cut away from the oldest known lands. Now

this implies that the low specific gravity beneath the continents has been deep enough and great enough to actuate isostatic movement, again and again, as the unloading of the land and the loading of the great water-basins has required. Differences of specific gravity adequate to this must have had a competent source; the differentiation must have been deep enough and great enough to have retained its efficiency through all the ages in spite of the persistent efforts of denudation and transportation to effect an equilibrium, not only, but it must have been great enough to leave the present undetermined resources available for future isostatic movements.

Now in a molten earth there should have been, at the start, a perfect isostatic balance, in the fullest sense of the term. An adequate cause for any non-isostatic differentiation in such a liquid mass seems wholly unassignable; certainly it has not been assigned; on the contrary, there are the most obvious reasons why the state of gravitative balance should have been initially perfect under the molten theory and should be preserved, for the dominant tendency of surficial action is perpetually toward equilibrium. The agencies within, like the agencies without, should have worked hand in hand to maintain the isostatic stability inherited from the original state. The present state does not, therefore, seem to flow logically from the assigned initial state.

But the case does not rest alone on logic, however cogent. If, in some unexplained way, there arose a deep differentiation of specific gravity of one type beneath the continents and of the opposite type beneath the oceans, and if the continents were thus forced to rise as their surfaces were cut away, the original embossments would, by this late day, have been cut down many thousands of feet, and we should now have free access to this much of the original molten interior of the earth. Our geologic forefathers, with their logical fidelity, so interpreted the deeper terranes so exposed in the heart of the old embossments, and some of us were indoctrinated with this concept in our youth. But as soon as petrologic science had come into possession of its modern efficient tools, it was discovered, almost simultaneously in the several critical regions then under competent investigation, *that the oldest known rocks are surface rocks and that the supposed original igneous rocks of the sub-crust are merely local intrusions.*

Taken together, these determinations constitute a formidable obstacle to the further acceptance of the inherited view. There is an absence of such observational testimony in support of the hypothesis of a once molten interior as we have a right to expect, such indeed as our geologic forbears did expect, not only, but supposed they had found. There is now added to this deficiency the adverse implications of such a deep differentiation of specific gravity as to force deformative readjustments, even at this late day, in spite of all previous partial adjustments.

This seems quite incompatible with a primitive molten state of the earth. To some of us its adverse import is wholly decisive. If there is a line of escape, consistent with logical fidelity to observed facts and physical principles, I must leave it to others to find it.

But we are less concerned with doctrines that fail than with doctrines that seem to hold out working promise of a true interpretation. The renewed protrusion of the continents and the continued receptivity of the oceanic basins, constitute the working prerequisites of geology, the very *sine qua non* of our science. The verity of their initiation and their maintenance throughout all recorded geologic history must be justified by any system of doctrine that has any claims to serious consideration. We feel, therefore, the call to dwell, in proportion to their importance, upon these fundamentals, in respect to which faith has been so much disturbed by recent disclosures.

The cosmogonic postulates set forth in the last lecture gave a specific working basis for an alternative picture of the early states and of the basal constitution of the earth. Briefly, these were a nebulous knot, as a center of growth, and much scattered nebulous matter as food for growth. The central portion of the knot was probably in a dominantly inter-collisional state, while the outer portion was almost inevitably in a dominantly orbital state, the latter circling about the former and limited outwardly by the sphere of control of the knot. The intercollisional portion should have rapidly collapsed into a dense spheroid so far as composed of rock-substance. The portion that revolved about this, after the manner of minute satellites, *i. e.*, satellitesimals, was collected only as the occasional collision of one satellitesimal with another drove them from their orbits into the earth nucleus or into the moon nucleus, or else they were driven in by infalling bodies from without, *i. e.*, planetesimals. The aggregation of the knot was not then a simple matter of gaseous collapse by cooling. What portion of the knot belonged to the intercollisional and to the orbital categories, respectively, is at present indeterminate, but progressive study tends to increase the probabilities that favor the orbital state and to diminish those that favor the intercollisional state. The nucleus of the knot that condensed in gaseous fashion to form the primitive core of the earth may have been no more than a minor fraction of the adult earth.

The scattered matter of the nebula, outside the knot, could apparently have been in no other than a state of movement about the sun. The scattered integers, whether moleclues or small aggregates, must apparently have pursued orbital paths of planetary type about the sun, that is, they must have been minute planets, or planetesimals. These were liable to fall into the earth knot in the course of their revolutions about the sun. The process must have been slow, as was also the ingathering of the satellitesimals of the knot, but each aided the other.

Internal Reorganization

An important deduction from such a genesis is the extreme heterogeneity it must have given the substance of the earth and the internal reorganization that such heterogeneity must have induced. There should have been, to be sure, some selective action, because the more inelastic material would concentrate faster than the more elastic matter, and the magnetic material would doubtless be gathered into the core, if it were magnetic, as is probable, faster than the non-magnetic material, but nevertheless much heterogeneity must have prevailed.

The atmosphere should also have served a distributive, as well as a slightly selective, function. As the planetesimals plunged into the outer atmosphere of the juvenile earth, they must have been largely dissipated into dust, if we may judge from the effect suffered by meteorites. These are largely consumed in the very thin upper air; only a very small fraction reach the earth's surface, and these are perhaps more massive than were the planetesimals. The planetesimal dust so generated no doubt floated long before it found final resting place on the earth's surface. Whatever heat was generated in the plunge into the atmosphere must have been largely radiated away from the upper regions, and the temperature of the accretional portion of the early earth could scarcely have been high.

The distribution of the accessions to the earth was thus incidentally conditioned by the atmospheric circulation. Descending currents naturally took precedence in bringing the dust down, but their dryness and turbulence near the earth's surface tended to hold the lighter material longer in suspension than the heavier; the action was hence slightly selective. Precipitation, largely associated with the rising currents, brought down all classes of dust within its reach. The first lodgment was further modified by the waters of the juvenile earth with some further selective action. On the other hand, the internal agencies that shaped the earth-body, potentially shaped also the work of the waters, for these followed the slopes of the land and gathered in the basins of the growing surface. Both the irregularities of the surface and the water, in turn, modified the circulation of the atmosphere that swept over them. And so the shaping of the earth-body by planetesimal growth was the composite product of the three great geologic factors, the atmosphere, the hydrosphere and the lithosphere, and should have been appreciably differentiated in specific gravity.

The Internal Structure of the Earth

The material of the accessions should have taken on a more or less stratiform arrangement under the action of the atmosphere and hydrosphere. Such molten matter as was poured forth from within likewise

should have assumed a rude stratiform arrangement. The combined effect of these processes was to give the earth a concentric structure, built up of very heterogeneous matter.

At the same time there were processes that tended to develop a radial structure traversing these stratiform layers much as the medullary plates of a tree trunk traverse its concentric layers of growth. Such lavas as rose from the depths doubtless either insinuated their way through seams, crevices, schist planes, and other lines of weakness, or fluxed pathways for themselves along ducts of their own making. In addition to these, the compressions that arose from growth, from transfers of molten matter from the depths to the surface, from changes of temperature, from molecular rearrangements under pressure, to secure greater density, all contributed to readjustments, recombinations and recrystallizations accommodated to the stress-differences whose least axis usually pointed in the direction of the surface. Lateral compression is a familiar phenomenon, vertical schistosity is its normal result. Diastrophic agencies came into action at a very early stage, and hence at a low horizon within the earth and their effects upon the structure of the earth were extended upward to the successive layers that were added at the surface. The earth is thus supposed to have acquired a vertical schistosity which had its initiation at great depths.

Partial Liquefaction and the Preservation of Solidity

The system of internal liquefaction and extrusion, assigned under the accretional hypothesis, departs rather radically from inherited views based on a supposed molten globe. It therefore invites critical consideration. Neglecting the very heart of the earth that is supposed to have grown from the gaseous nucleus of the knot of the nebula—the conditions of which are least certain and whose proper treatment is inhibited by time—let it be noted that the matter gathered to the earth-nucleus as aggregates, or as accretional dust, was highly heterogeneous. Assuming that it was cold when deposited, heat arose from compression as layer was added to layer. Such radioactive matter as the accessions contained also generated heat at multitudes of minute points. The increasing pressure, so far as uniform on all axes, antagonized liquefaction. With such a slowly rising temperature, so distributed and so antagonized, it may be assumed safely that liquefaction would start, so far as it started at all, with those points where particles mutually most soluble or most fusible were in contact with one another, or where most heat was generated by radioactive action, or where the two cooperated. If the mobile matter so generated slowly were removed about as fast as it gained workable volume, the main surrounding mass would remain solid. We have just named a list of stresses that may well be held competent to force at least all the lighter liquids toward the surface. We shall presently discuss these further.

It is now known from concurrent evidence—the most conclusive of which springs from the recent work of Michelson, Gale and Moulton on the body tides—that the earth is highly rigid and elastic. Aside from cosmogonic considerations, the grounds of which we have already challenged, we know of no reasons for assigning the earth any other than the rigid state, at any time during the geologic ages. The planetesimal hypothesis assumes that the elastic rigid condition prevailed, at least in the outer half of the earth, throughout the history of its growth. It holds that the accessions were added in the solid state, and that such liquefaction as later arose in this solid matter must always have been merely partial and selective, and that the liquefied material was forced, by prevailing stresses, to the surface as fast as it reached working volume. This is a radical departure from the inherited concept of a molten interior. The stresses that are believed to affect the interior of the earth are serious obstacles to the supposed existence of great reservoirs of liquid matter, lying quiescent for long ages, and undergoing magmatic differentiation under assumed static conditions. The great distortions that have certainly affected the earth to the greatest accessible depths and that are most intense in the deeper rocks, seem to be specific evidence at variance with the assumption of such protracted quiescent conditions. The newer view postulates effective stress conditions permeating the globe at all times during its adolescent, as well as adult, history, and that these effective stresses tended to force to the surface all mobile materials, except possibly some whose specific gravities were sufficiently high to resist the ascensive pressure.

The new view makes its first and most fundamental appeal to the differential stresses imposed by changes of rotation. The primary stresses of rotation give evidence of having been the greatest that have been imposed upon the body of the earth, except those of gravitation, which are hydrostatic. According to Sir George Darwin, the rotational stress-differences are eight times as great at the center as at the surface. The potential stress-difference that would become actual at the center of the earth by the arrest of the existing rotation amounts to 33 tons per square inch. The tidal stress-differences have a similar distribution, but they are relatively feeble, though persistent and pulsatory. The more general class of stresses that arise from loading and unloading through erosion and transportation perhaps have a somewhat similar distribution. The static stresses due directly to gravity, range from one atmosphere at the surface to about three million at the center. From these cooperating stresses, a persistent urgency to escape to the surface is believed to have been brought perpetually to bear on the mobile and, in the main, lighter liquid material as fast as it was generated. The less soluble, more refractory, and, in general, denser material remained behind, but probably approached mobile conditions sufficiently to permit rather

free molecular rearrangements, especially such as would give higher density. Under the general principles of endothermic action, heat-absorbing combinations may be assumed to have taken place with corresponding limitations of liquefaction. Crystalline rearrangement in the interest of density, and at the same time consistent with high elastic rigidity, is thought to have been favored and to have taken such forms and mutual relations as to give schistosity favorable to deformative movements.

Such liquefaction as took place would consume heat, in addition to that of the endothermic recrystallization, while the escape of the liquid material to the surface carried out this latent heat, as well as a due portion of sensible heat. Incidentally, the escaping lavas carried out also radioactive substances and gradually reduced the heating process. The compressibility also declined with the progress of compression, and this source of heat also declined. With compression and with the increase of static pressure, the rigidity should have increased. So the complex process inherently tended to an end of its own making.

The process of vulcanism is thus made a means of removing to the surface the excess of internal temperature, as it arises, together with the source of that temperature, performing in this way a service closely analogous to the process of perspiration in the animal body. This view is eminently consistent with the tidal and the other astronomic indications of the elastic rigidity of the earth that have recently become so declared, and also with seismic data whose evidence is less complete, though strongly tending in the same direction. It is also in harmony with the conclusion, reached by special students of the subject, that radioactive substances are chiefly concentrated at the surface. Still further, it is in harmony with the acidic composition and the low specific gravity of the outer part of the earth. The view seems also to be in fair consonance with what is known of the eutectic nature of rocks, the selective production of magmas, and the progressive differentiation of magmas, both in their ascensive and in their descensive careers.

Such effusive matter as reached the surface in the earlier stages was buried later by the infalling planetesimals and planetesimal dust, and so it was again subjected to selective processes, with further differentiation, and this might be repeated again and again, so that, in the end, there was a progressive concentration of the more refractory and the denser material toward the central parts, and of the lighter and more solvent, toward the outer parts. This selective action was of course superposed upon the selective ingathering of planetesimals, dependent upon magnetic and inelastic properties, and upon the selective action of the atmosphere and the hydrosphere. Thus, under this concept, the earth came to its maturity slowly under selective agencies that tended at all stages to differentiate its material.

So also, under this concept, deformative agencies came into action early and persisted through all stages of growth, though at all times more or less periodic in their specific manner of action. These deformative agencies now claim our attention.

Origin of the Great Physiographic Features

The most notable of past attempts to account for the continental embossments and the oceanic basins, in accordance with the theory of a molten earth, was undoubtedly that of Lothian Green, who appealed for his first premise to the fact that a spherical surface embraces the maximum of matter within the minimum of surface, and that this should have obtained in the primitive state of the earth. For his second premise, he urged that the globe, when forced to shrink from cooling, would tend in the direction of that symmetrical form which had the minimum of content with the maximum of surface, the tetrahedron. The cogency of this logic I must leave to your own judgment. On this concept, arose the doctrine of the tetrahedral earth. Assuming that the duodecahedral form of the tetrahedral type was early attained, Lothian Green located the continental protuberances at certain of the angles and the oceanic basins at alternate angles. The logic was frankly based on the doctrine of a molten earth and does not seem to be transferable to an accretional earth.

Under the planetesimal view, it seems scarcely less than necessary to assume that the great differentiations of the earth's surface arose from specific deformative stresses that came into action early in the process of growth and were more or less recurrent throughout the whole adolescent history of the earth. The controlling influence that gave shape to the juvenile earth seems to have arisen from changes of rotation. Rotation is far and away the greatest of all the deformative agencies to which the earth has been subjected. Its residual effect—not its total effect—is now seen in a radial difference of thirteen miles between the polar and the equatorial radii, but this is only the net result of a long series of earlier effects of opposite phases. The rotational stresses permeate the entire mass of the earth and, as already remarked, are greater at the center than at the surface. Such pervasive and penetrating stresses are preeminently suited to produce broad, deep, and pervasive deformative effects. The breadth and symmetry of the direct rotational effects are seen in the great graduated equatorial bulge and in the broad graduated polar depressions. This symmetrical distortion of the sphere satisfies the *primary* demands of rotation *but not the incidental demands of changes of rotation.*

The bulging and the depression of these broad tracts involved tension and compression in the segments so affected, and lines of accommodation to these stresses were requisite. It is assumed that these

lines of accommodation would define as few broad divisions of appropriate form and magnitude as would serve to satisfy their main requirements, leaving minor requirements to be satisfied by minor accommodations. It is assumed further that these major divisions would be so related to one another as to act reciprocally, one set rising in the equatorial regions, the other set sinking in the polar regions, and the reverse, according as the rotation was accelerated or was retarded. Since the earth is held to have been a rigid body, it is held—and this will bear emphasis—that the units of action would be as few as could fairly satisfy the main demands of the case, and that these parts would be as simple and symmetrical in their forms and in their working relations to one another as practicable.

The probabilities of successive oscillations between acceleration and retardation of rotation are dependent on the specific history of the formation of the globe. Under the planetesimal hypothesis, a part of the earth's rotation was inherited from the knot that formed its center of growth, but an important portion also arose from the momentum of infalling planetesimals. In the nature of the case, some of the infalls tended to accelerate rotation, while others tended to retard it, and so changes in the ratios of these two classes, arising from irregularities in the distribution of the planetesimals, tended to change the rate of rotation. Time does not permit me to give reasons for the conclusion that there was an *equilibrium rate of rotation* about which oscillation should have been an inherent tendency.[2]

Now with every increase of acceleration there was depression and crowding at the poles, while there was bulging and tension at the equator, and between these rising and falling areas there was a neutral or fulcrum zone which neither rose nor fell, but under which a shift of matter took place from the depressed to the lifted side. With every retardation of rotation, there was the opposite effect. No portion of the earth was free from these influences. Just how the earth accommodated itself to these profound stresses is our problem. So far at least as the tensional alternative is concerned, there are many phenomena in nature that teach us how the easement is accomplished, and where the yield tracts lie. There are some which show us less simply and less unequivocally how relief from compression is effected. The most instructive example is found in the cooling of lava into basaltic columns. From a study of these, it is seen that the required accommodation is effected by three parting planes diverging from the points of greatest tensional stress, at angles of about 120°. There is, of course, much variation from this precise angle when the material is even moderately heterogeneous, for the action is but a mechanical accommodation of the

[2] These are given in "The Origin of the Earth," now in the hands of The University of Chicago Press.

stresses, and has none of the precision observed in the formation of crystals.

On the basis of this principle of action, it is assumed that a threefold partition would obtain at each of the poles when under tensional stress, and that the yield tracts would extend to the fulcrum zones. The position of the two fulcrum zones would shift with the degree of oblateness, but they may be conveniently spoken of as lying not far from 30° latitude north and south. The segment so defined surficially would form only one half of the reciprocating unit. This, as seen on the surface, would have the form of a spherical triangle. The other half-unit that must cooperate with this one in reciprocal action, could be formed in the simplest and easiest way by similar yield lines crossing the equatorial belt and converging to a point in the fulcrum zone of the opposite hemisphere. The reciprocating pairs would thus consist of similar triangles—at the surface—back to back, the one wholly in the rising area, the other wholly in the sinking area. Three such reciprocating pairs would then surround each pole. If one set took precedence, as would be natural, the other would be forced to alternate with it. The two sets would thus interlock across the equatorial belt. Each working pair of triangles would form a quadrilateral at the surface, and would extend to the center, where the six apexes would come together. The earth would thus be divided into six pyramidal sectors, symmetrically related to the axis of rotation, symmetrically related also to the stresses to which they must yield, and embodying a very simple mode of meeting the requisite changes of form. This concept of a hexafid earth has some resemblance in form to the factors of the tetrahedral earth of Green, but it starts from entirely different premises and is based on radically different considerations. The hexafid division is in no sense a crystalline process, but merely a mechanical adaptation to variations of stress imposed by the pervasive effects of changes of rotation.

But no very close approach to perfect hexafid partition could probably arise from stresses working on the complex texture of an accretional earth. Besides, certain definite tendencies to inequality of development appear to have arisen as the segmentation went on. There was the law of progressive dominance. Whenever in the course of growth, any division came to preponderate in mass or density, this very preponderance gave advantage in the acquisitions that followed. Dominance not only tended to its own perpetuation but to the increase of its own preponderance. It naturally resulted that some of the sectors grew more than the others. The basins of the southern hemisphere seem to have taken precedence of those of the northern, and the basins of the Pacific took precedence over those antipodal to them. These two preponderances united to give a preponderant water hemisphere, with its center near New Zealand, and a preponderant land hemisphere, with its center in southwestern Europe.

There was also the law of alternation. When any pyramidal sector sank from superior weight, it crowded aside the adjacent sectors, and the belts of easement between them were squeezed in proportion as adjacent basins sank. And so depressions and elevations alternate around the globe.

There was also the law of opposites. Whenever any pyramidal sector sank by reason of superior weight, it favored reciprocal rise on the opposite side. So, as a matter of fact, depressions stand opposite to embossments about the globe.

There was also probably an adjustment of the sectors relative to one another. Ideally, the sectors might stand point to point, but this is an unstable adjustment, and amid the inequalities and distortions that arose, the sectors would naturally be shifted in the direction of least resistance, so that the sinking heavy sector, on one side, would come to stand opposed to a yield tract on the antipodal side. And so basins should have come to be antipodal to protrusions, if not already so at the outset. In harmony with this, it may be observed that the North American embossment stands opposite the basin of the Indian Ocean, the Australasian embossment opposite the basin of the North Atlantic, the great east central basin of the Pacific opposite the great protuberance of Africa, the South Pacific opposite Asia in part, the Antarctic continent opposite the Arctic basin, while the great oceanic sag around the Antarctic continent stands over against the great land belt in the high latitudes of the northern hemisphere.

There are a multitude of interesting details and qualifications, and some incongruities, upon which it would be delightful to dwell were there time. In the very tentative and imperfect presentation of this doctrine which alone is possible here, let us content ourselves with the merest glance at certain salient illustrations of the suggested segmentation of the earth.

Starting with the hemisphere of heaviest segments and largest present increments—which therefore probably took precedence in action—the three oft-noticed poleward-pointing extremities of Africa, Australia and South America illustrate the three-fold division of the polar region, in fair harmony with the terms of our interpretation. Following the South American axis northward to the vicinity of the fulcrum zone, the ideal scheme demands bifurcation and angulation. In harmony with this, marked structural features diverge to the northwest and northeast. The former strikes through the Isthmus of Panama, the states of Central America—with the Antilles as a duplicate line—and onward to the vicinity of the fulcrum zone of the northern hemisphere, where the dominant structural lines should turn in a second angulation, toward the north pole. This is partially realized, but is much obscured by superimposed features that cannot here be discussed.

Turning back to the point of bifurcation in South America, "the Backbone of Brazil" strikes northeasterly, and, save for the interruption of the constricted connection between the two Atlantics, is continued in the structural lines of northwestern Africa to the critical zone of angulation on the borders of Africa and Europe.

Turning back again to the south African axis, it is to be noted that, near the proper latitude for bifurcation, two ancient crystalline terranes diverge in lines nearly parallel to the borders of the continent, and extend across the equatorial belt to about the assigned zone of angulation in the northern hemisphere, where converging deflections toward the north pole are encountered, notably the west border of Europe and the Ural mountains.

Both Australia and New Zealand have southern prolongations that seem to represent, in a duplicate way, the third meridional easement tract of the south polar regions. At about the assigned latitude, a broad strand of northwesterly trending structural lines run through the East Indies and connect Australasia with southeast Asia. The trend of this remarkable strand is continued to the latitude of the northern zone of angulation where a complex series of divergencies is encountered with a northerly and northeasterly trend.

In perfect symmetry and completeness obtained, there should be three main yield tracts from the poles to the fulcrum zones not far from 30° Lat. N. and S., while between these there should be oblique trends. At the same time, the great continental embossments and the great abysmal basins of the two hemispheres should stand in alternate or offset positions relative to one another. These basal requirements of the interpretation should be rather distinctly discernible, though much obscured by outgrowths and distortions. The North Atlantic should be offset to the west relative to the South Atlantic, North America relative to South America, the North Pacific relative to the South Pacific, Asia relative to Australasia. These radical requirements are strikingly realized. North Africa and Europe are less strikingly offset relative to South Africa, but the tendency is marked. The obliquity of the trends in the equatorial belt is strikingly displayed in the East Indies, and in the West Indies and isthmian connections between the Americas. It is betrayed also in the trends of the singular physiographic features that affect the junction area of Africa, Asia and Europe.

Time will not permit us to lapse into explanatory details. The scheme of interpretation only calls for the detection of a deeply buried embryonic framework on which other agencies have built the adult configurations of the globe, and on which they have imposed their own characteristics.

Dynamic Organization of the Atmosphere

The working relations of the primary segmentation of the earth-body to the dynamic organization of the atmosphere, were close, both in causation and in effect. There were striking analogies between them. The broadest features of the atmospheric circulation are now, and probably were in the earth's juvenile stage, as simple as the broad features of rotational deformation. So too, the secondary adjustments of the atmospheric circulation in the two hemispheres are now, and probably were from the outset, very similar to the secondary adjustments of the earth-body. All the significant features of this analogy can not even be mentioned. We can simply note that, over the great oceanic basins in the latitudes of the fulcrum zones, there are oval systems of circulation centering about the areas of high atmospheric pressure, which match, in a general way, the centers of high specific gravity in the basin sectors below. On the borders of these ovals, there are tracts of conflict and of high precipitation, corresponding to the disrupted adjustment tracts of the earth-body below. These gyratory systems and these tracts of precipitation influenced fundamentally the deposit of planetesimal dust, and thus gave direction to the growth of the earth, while, at the same time, they themselves were profoundly influenced by the configuration of the earth-body, and by the waters gathered into its great basins. And so the three great factors, atmospheres, hydrosphere, and lithosphere, cooperated in building up and giving shape to the great features of the earth.

It is obvious that whatever planetesimal material found lodgment on the lands was subjected to greater leaching than the portions that fell into the waters. It appears that the average specific gravity of the elements leached away must have been slightly higher than that of the portions left behind—in the form they would finally take after burial and metamorphism—so that the protuberances came to be formed of slightly lighter material than the basins, and hence, in deformative actions, the basins took precedence in sinking and the continents were accommodated to this. This contributed to the permanency of the great features of the earth which, in turn, influenced the atmospheric circulation.

We find then, in this mechanism, reasons for the observed lower specific gravity of the continents and the higher specific gravity of the sub-oceanic material. In this, also, lie reasons for the continuous maintenance of the continents, and hence the perpetuation of continental life, as well as the reciprocal maintenance of shallow-water oceanic life. Some of the greatest generalizations of geology thus find inherent support and adequate elucidation in the very origin and constitution of the continents and of the ocean basins, while in this inherited constitution

are found cogent reasons why these great features are, and should ever remain, protrusive and depressive, respectively.

We are thus brought to conditions that are fundamental to the evolution of life on the earth. This fascinating theme I must leave to my successor. It is to be noted, however, that the physical evolution of the earth predetermined, in large measure, the lines along which the life evolution of the globe was compelled to proceed.

When the great embossments and the deep basins had become determinate, and when the earth's growth had been completed, there followed a long history of denudation of the land, of filling of land-girt basins, and of building of terraces about the borders of the lands. There were base-levelings and great transgressions of the seas, covering sometimes half the continents, but never, in the known history of the earth, wholly submerging them. Before complete submergence was reached, rejuvenation intervened; the continents were re-elevated and the seas withdrawn by further sinking of their basins, and a new period of life evolution ensued. The whole sea-history seems to have been a succession of encroachments followed by retreats, with correspondent expansions and restrictions of sea life, while the land areas were reciprocally reduced and expanded with corresponding restrictive and expansive evolutions of land life. Thus the familiar evolutions of the well-known history of the globe went forward controlled, in a profound way, by the hidden powers of renewal inbred in the early organization of the earth-body. The whole evolution was, at the same time, profoundly influenced by the constitution of the atmosphere and by climatic conditions.

The Evolution of the Atmosphere

The evolution of the atmosphere under the older cosmogonic views took the form of a great decline from a vast primitive envelope through a long series of depletions, to the relatively emaciated conditions that obtain to-day, under this interpretation. All this is too familiar to need more than simple reference. The alternate view here entertained pictures the atmosphere as growing up from small beginnings and maintaining itself throughout the ages by alternate enrichment and depletion from within and without. A bare sketch of some of the least familiar of these tenets is all that can be given.

The lower atmosphere is eminently collisional, each molecule colliding with other molecules with prodigious rapidity. This condition prevails upwards until the tenuity of the air becomes so great that molecules, bounding upward from encounters, find no other molecules in their path until gravity has had time to arrest them and draw them back toward the earth center. There are thus substituted vaulting leaps for to-and-fro motions. A fountain-like zone supervenes upon the the collisional atmosphere. This krenal atmosphere is necessarily very

attenuated, but the vaulting molecules do not entirely escape collision with one another. From these mid-vault collisions rebounds, more or less tangential to the earth, arise in a certain proportion of cases. Under the law of probabilities, a certain percentage of molecules thus rebounding have sufficient velocities to take orbital courses about the earth. When they have once entered upon these orbital courses, molecules may remain indefinitely in them, if not driven from them by some intervening agency. This introduces a distinctly new factor, for this permits accumulation to go on until this very accumulation checks itself. The logical series consists, therefore, in a vaulting ultra-atmosphere, springing necessarily from the summit of the collisional atmosphere, and, in turn, giving rise to an orbital atmosphere which must tend to accumulate until an equilibrium is reached, in which the orbital atmosphere gives back, or throws outward, as many molecules, in the long run, as it receives.

Now a limit to the outward extent of the vaulting molecules and of the orbital molecules is found in the limits of the sphere of the earth's control. The minimum radius of this, according to Moulton, is a million kilometers (620,000 miles), the maximum radius, a million and a half kilometers (930,000 miles). Under kinetic laws there seems no logical escape from the conclusion that a certain proportion of molecules vault to the limit of this sphere of control and beyond it, and that orbital molecules occupy, in their extremely attenuated way, the whole of this sphere also. Those molecules that pass beyond this sphere enter the sphere of the control of the sun and are lost to the atmosphere of the earth.

Similar logic applies to the ultra-atmospheres of the sun whose sphere of control envelopes the earth. The sphere of control of the earth has been sweeping through the sphere of control of the sun throughout the entire history of the earth. As a result of these relations, it is logically inferred that there has been a feeding in of molecules from the sun's ultra-atmosphere, during the whole evolution of the earth, and that these exchanges have tended toward an equilibrium by which the scanter atmosphere, whichever it may happen to be at any stage, has been fattened by the richer atmosphere. Logically this relation obtains to-day.

If this interchange were solely dependent on mechanical action between the molecules, its quantitative sufficiency might possibly be open to question, but this interchange is the basis for cooperative action by electric and magnetic agencies. The competency of these, while as yet undetermined, is very probably important. Electric and magnetic actions not only abet the mechanical distribution, but offer possible, if not probable, solutions of the grave problems that arise respecting a constitution of the early atmosphere suitable for the generation and

maintenance of terrestrial life. It is a notable fact that the actively combining molecules of the earth's atmosphere belong to a special class which have a general tendency to bear a negative charge of electricity, among which the vitally essential element oxygen is chief.

Functions of Oceanic Circulation

The superficial circulation of the oceans is a result of the winds, but the deep circulation appears to be the product, in part, of the differences in density of the sea water. At present, two great influences seem to be contesting for the mastery of the deep sea circulation, and, through such dominance, for the mastery of our coming climate. The dominant circulation is now controlled by the polar regions, especially by the Antarctic. The density of the sea water is there increased by low temperature and by some concentration of salts through freezing. With this higher specific gravity, the polar waters outweigh the warmer waters of the lower latitudes and descending flow along the ocean bottoms into the depths of the abysmal basins, rising ultimately in the equatorial tracts to depress the temperature there and to force the heated waters poleward. This deep-sea circulation is, without doubt, one of the elements that perpetuate the semi-glacial conditions of our times. Over against this, is the work of evaporation in the arid tracts, notably the 30° belts. By such evaporation, the waters of the Mediterranean are distinctly higher in specific gravity than those of the Atlantic and, as a result, the dense, though warm, saline water flows out through the Straits of Gibraltar into the Atlantic, spreading out in spatular form nearly across the North Atlantic, and descending to great depths. Similar dense waters flow out from the Red Sea, while under the great evaporating belts analogous condensations are taking place, the effects of which are felt to very notable depths. It is not known whether this increase of density in the warm tropical regions is gaining upon the density-effect of the polar regions or not. We must wait for future observations to decide how the battle is going. But it is clear that if the intensities of polar cold were mitigated, as in time they no doubt will be mitigated by the wearing down of the heights of the land and by the encroachments of the sea, there is reason to believe that the density which springs from evaporation in the low latitudes will gain the mastery over the polar water, and will sink to the bottom of the sea, filling the basins with warm water. This heated water creeping to the polar regions would carry warmth where now there is frigidity, a natural water-heating system of a stupendous sort. This seems the most probable explanation of the extraordinary fact that throughout the larger portion of earth history, so far as we are able to decipher it, mild climates, even sub-tropical climates, have prevailed in high latitudes, notwithstanding the adversities of their long winter nights, so notably

devoid of heat from without. It seems probable that the conditions which favor the dominance of polar cold, at intervals, and the dominance of tropical warmth, in the longer periods between, is determined by the elevation and the configuration of the land, especially that in the polar regions. The present cold oceanic circulation is known to be dominated by the Antarctic Continent and perhaps sprang initially from the geologically recent elevation of that continent. As it shall be cut away by the wear of the surface and the gnawing of the sea, its dominance will no doubt disappear and the dominance of tropical circulation take its place.

Correlated with these temperature changes of the oceanic waters are atmospheric absorptions and interchanges of gaseous content of a vital nature upon which time forbids us to enter.

Projecting these interpretations of the present oceanic junctions back through the geologic ages, they seem to imply successive alternations of remarkable warmth in high latitudes and glacial cold in relatively low latitudes, and corresponding climatic stress effects on life evolution and life distribution.

This system of interpretation assumes that the atmosphere has been maintained from the beginning of the earth's mature history in a state of approximate equilibrium with the atmosphere of the sun; hence an essential uniformity in volume and in constitution have been preserved unbroken from the dawn of life to the present. At the same time, it is held that, subordinate to this essential uniformity and this equilibrium, there have been notable fluctuations in volume and in constitution, due to variations in feeding from the interior of the earth, variations of depletion by chemical interaction with the rocks, and variations in the degree of absorption into the hydrosphere. The atmosphere has been subject also to variations in the retention of solar heat—the essential factor in climate—due not only to variations in constitution, but to variations in the intensity of vertical circulation promoted by surface features. Out of combinations between this automatic regulation of the fundamental constitution of the atmosphere and the oscillations of terrestrial conditions that arise in succession, spring, we think, the essential features of the evolution of the earth's climate, so far as they are terrestrial at all.

Thus far I have tried to emphasize the more fundamental of the dynamic agencies that seem to me to lie back of the physical evolution of the earth. Until the whole history of the earth, early and late, shall be worked out into an accepted interpretation, the *reasons* for the interpretations we entertain are quite as vital as the interpretations themselves. The breadth of the theme has made imperative a most cruel and partial selection. I think I may assure myself that no one else will fully justify the partiality of the selections I have made. It has

seemed to me, however, more vital to dwell upon the genetic and the fundamental, than upon the more declared features of the record. These are better deployed, relatively, in the literature of the earth-sciences, and are accessible in our ampler texts. They are the common ground on which we all unite, with more or less complete unanimity.

In a closing sketch of the accepted eras of the earth's adult history, it will be possible to touch only on a few high points. Our scant selection can be justified only by frankly affirming that there are other high points quite as worthy of emphasis.

Great Eras of Earth History

The lowest accessible record is found in a great complex of crystalline rocks whose metamorphism has somewhat obscured their original state. An essential portion of the complex terrane is the work of its own time; the rest was intruded at later dates. The primitive portion carries clear evidences that it was formed at the surface by sedimentary processes, eolian, aqueous, igneous, or pyroclastic. But this portion has been so much intruded, or traversed, by lavas escaping the pressures of the interior, that this immigrant factor obscures and, in some degree, masks the prior sedimentary element. It is to be noted, however, that all subsequent effusions of lava traversed this basal series, and so added to its complexity, and that it was affected also by all the later deformative actions. None the less, eruptive action seems to have been more prevalent in these Archean ages than in those that followed. In its earliest adult stage, the fires of youth seem yet to have been specially active, and the master events seem to have centered about igneous and metamorphic action—but it would be a serious error to overlook the vital contribution that the atmosphere and the hydrosphere cast into this, the earliest of the accessible lithographic records. There are signs of life, but they reveal little of its nature.

There followed this basement complex, a series of great terranes in which the dominant elements were more declaredly the products of aerial decomposition and of aqueous erosion, assortment, transportation, and deposition, though here the igneous factor cast in a very notable contribution also. There are left few identifiable relics of life, but there is abundant evidence of organic action. Between this Proterozoic group and the underlying Archean, lies a great unconformity, and within the group itself there lie scarcely less great unconformities, all of which imply that great movements intervened between times of relative quiescence, a feature that ran through all subsequent history. Even in this early age, there are signs of glaciation in mid-latitudes and apparently at moderate elevations (Coleman), a feature of vital significance in the interpretation of the climatic history of the earth.

Following another great interval, marked by unconformity, the

Paleozoic Era was ushered in, and with it the first good record of the specific forms of life. The feature of supreme interest, the first good record of life, falls to the lot of my successor, who will give its interpretation and sketch the subsequent life evolution. During the Paleozoic Era there was a series of relatively quiescent periods during which the joint forces of the atmosphere and the hydrosphere made great progress in cutting away the protuberances of the continents and depositing the débris in great sub-sea terraces about the continental borders and in the infra-continental basins, thus partially base-leveling the land, and partially filling the basins, so that the ocean waters crept forth on the borders of the land and seemed to threaten complete submergence. But rarely was more than half the continent conquered before internal stresses had accumulated in sufficient force to bring on another epoch of deformation and continental protrusion, pushing up the land and pushing back the sea, restoring in a measure the old status and preparing the way for a new sea-transgression. After some half dozen periods of such oscillation, a more marked series of deformative movements ensued, with a more pronounced rejuvenation of the land. With this came also the most remarkable of all known glaciations. Mantles of ice gathered on lands near the circles of Cancer and Capricorn and left distinctive records which, however seemingly incredible, are incontestible. To add to the seeming strangeness, the evidence clearly points to low altitudes of the land and to the descent of the land-ice into the waters of the sea which bore icebergs to long distances and formed extensive glacio-natent deposits. That the great deformative action had some genetic relation to this remarkable climatic episode, seems eminently probable, but it does not seem to have accomplished this directly by the elevation of the sites of glaciation.

These remarkable events ushered in the Middle Ages of geology—as much a misnomer as the Middle Ages of human history—the early stages of which seem to have witnessed the greatest extension of land, and apparently the greatest general aridity of climate, known to geological history. But, in time, the persistent gnawings of the atmosphere and the hydrosphere—geologic twins in never-ceasing activity—cut down the great embossments and permitted the sea to transgress the land repeatedly before the Mesozoic Era closed. But, as ever before, the land persisted and was periodically renewed. After fewer oscillations than in the Paleozoic Era, another notable epoch of diastrophism intervened, and the Cenozoic Era was inaugurated. Glaciation seems to have recurred in mid-latitudes (Atwood), but the evidence is as yet less ample than in the preceding transition.

After a shorter succession of base-levelings and sea advances, separated by minor rejuvenations of the land, there came the recent great series of deformations which gave rise to the present great folded moun-

tains, the present great plateaus, and the special configurations which the continents and oceans now bear, save in relatively trivial details. Close on the heels of this great diastrophic epoch came on the last great glaciation in mid-latitudes. At that time, ice-sheets crept down on the American plains to the Ohio and Missouri rivers, and over the northern plains of Europe, while in the southern hemisphere and on mountain heights, even in the tropics, there were signs of a general depression of temperature. There were repeated advances of the ice-sheets, separated by milder intervals during which retreats took place, showing, even in such episodes, the tenacity of the principle of oscillation in terrestrial ongoings. It is only recently, geologically speaking, that the ice-sheets have retreated from the lands where half the civilized world now lives. Glaciers linger in the polar fields and on the mountain heights. The deep sea is still icy cold. The contrasts of climate are sharp. We seem to be yet in the cold segment of the climatic cycle. Whether we are about to emerge into a period of typical mildness, or are yet to suffer a recurrence of the ice invasions, is a geologic detail beyond safe prophecy, but that such emergence is to follow, sooner or later, seems assured by the long history of oscillations of the past and the persistence of recovery that seems to be firmly based on the automatic regulation of the atmosphere and of climate inbred in the very constitution of the earth.

PROBLEMS ASSOCIATED WITH THE STUDY OF CORAL REEFS. III

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Upgrowing Reefs in a Rising Ocean.—Are we then to regard Darwin's theory of subsidence as completely established? Not yet, for there are two alternative theories that have not been mentioned. It has already been pointed out that all the visible features of sea-level reefs themselves, apart from the neighboring volcanic islands, can be equally well explained by any one of some eight or nine hypotheses, provided that the postulates of the hypotheses are accepted; and that appeal must therefore be made to some associated problem in order to find a crucial test by which the true theory can be selected. Let it now be recognized that all the features of barrier reefs and of their embayed central islands also, which according to Darwin's theory are explained by the subsidence of the reef foundation beneath a stationary ocean surface, can be equally well explained by supposing the ocean surface to rise over a stationary reef foundation, as in Fig. 30. It is only by appeal to certain rather recondite associated problems regarding the rest of the world that this second possibility can be excluded, and the first fully justified.

In discussing this aspect of the problem we must recall at the outset that an adequate theory of coral reefs has to account, not only for the last touches given to existing sea-level reefs, but also for their relatively remote beginning; that it has to explain not only sea-level reefs, but also elevated reefs, formed in an earlier epoch and now standing hundreds of feet above sea-level; that it has to provide reasonable conditions for the great submergence indicated by the deep embayments of Kandá-vu, Tahaa, and many other islands; that it has to account for the occurrence of small remnants of large volcanic islands within large reefs; and that it has to explain the heavy limestones in such uplifted atolls as are found in the Loyalty islands and elsewhere, as well as the thin terracing reefs that are uplifted in the New Hebrides. In short, an adequate theory of coral reefs involves great and small terrestrial changes such as will cause great and small submergences and emergences at different dates in the later ages of the earth's history. If we account for all such changes, not by local subsidence of the reef foundations, but by changes of the sea surface caused by deformation of some

other parts of the sea floor, we must postulate repeated crustal movements of so enormous a measure that they become improbable to the point of incredibility; for it must be remembered that whenever the sea surface is to be raised 1,000 feet by upheaval of a part, such as a tenth, of the sea floor, that part must be upheaved at least 10,000 feet; and more than 10,000 if, as is very probable, its upheaval is accompanied by a contemporaneous depression of some neighboring part. It is therefore consistent with terrestrial economics to account for the great submergence which coral reefs demand by subsidence of the needed amount in the area where and at the time when the reefs are formed.

Furthermore, if the submergence indicated by coral reefs and their associated islands be explained by a rise of sea level, let it be remembered that this requires the submergence to be everywhere—on all continents and all islands—the same in rate, date, and amount, except where local crustal movements introduce variety into its measure. In view of the apparent variety in the date and amount of submergence by which existing embayments of insular and continental shorelines have been formed, the appeal to local movements as a cause of the variety may be so frequent that such movements will become the dominant control of submergence, each in its own region. Indeed the explanation of all coral reefs by a rise of sea level recalls the explanation given by Suess, about thirty years ago, for all high-standing atolls by a general depression of sea level; as soon as the diversity in the altitude of such atolls is recognized, their position must of course be explained by diversity of crustal movement rather than by a uniform change of sea level: so, I believe, when the submerged embayments of the world's coast lines in coral-reef regions and elsewhere are attentively examined, and when the emerged coastal plains of certain continental borders are closely studied, many diversities in the rate, date, and amount of their submergence or emergence will be discovered. Such diversity will then be best explained by local crustal movements, and world-wide changes of sea level will be given relatively small values.

But let me state explicitly that it would be highly illogical to exclude so manifestly possible a factor as a universal change of sea level from all share in submerging shoreline embayments or in laying bare strips of coastal plains; it is because any change in sea level must be smaller than the uplift or depression of the sea floor which causes the change in the same proportion that the uplifted or depressed area is smaller than the total ocean area, and because the sea integrates all the positive and negative changes which various local movements tend to produce in its surface level, that it seems most reasonable to explain regional submergence, long continued in time and great in amount, such as that involved in the origin of many coral reefs, chiefly by subsidence in the region and at the time concerned.

The Glacial-Control Theory of Coral Reefs.—There is one phase of the theory of a rising ocean, pointed out by several writers in the last thirty or forty years and lately discussed more fully by another, that demands further examination. This is the idea that the drowned-valley embayments, which we have been taking as signs of subsidence, have been submerged by the rise of the ocean surface as the water, which was abstracted to form the continental ice sheets of the Glacial period, was returned to the ocean when the ice sheets were melted in the milder climate of Postglacial time. This in its fully developed form has been called the Glacial-control theory, and its discussion evidently involves many associated problems besides those already mentioned. Its essential postulates and processes are as follows: Coral-reef flats are supposed to have been formed around or upon still-standing foundations in Preglacial time, hence presumably for the most part by outgrowth; the ancestors of atolls, now the commonest kind of reefs, were formed around volcanic islands that had stood still long enough to be worn down by subaerial erosion nearly to sea level or by marine abrasion a little lower; the ancestors of barrier reefs were similarly formed around islands that are not old enough to have been worn down; lagoons were shallow or wanting, because solution is not an adequate cause for them. As the Glacial period came on, the surface of the ocean was lowered by the imprisonment of a large volume of water as ice on the lands; it has been calculated that the lowering of the entire ocean thus caused was between 200 and 300 feet. The ocean was then chilled as well as lowered, and thereby the corals of most reefs were killed. The waves of the lowered sea attacked the undefended flanks of the dead reefs and cut them back in flat platforms. Next when the climate became milder and the ocean surface rose again, reefs were reestablished and grew upwards on the platform edges of the earlier reef flats, and thus the barrier and atoll reefs of to-day have been built up around the lagoons that they enclose. It thus appears that the Glacial-control theory accounts only for the reef rims and the lagoons of atolls and barriers, and that the great undermass of the reefs is explained according to the theory of outgrowing reefs on still-standing foundations, but without the action of solution in the excavation of the lagoon.

All the causes here mentioned appear to be true in quality, but their quantitative value is uncertain. The oceans must have been lowered and cooled during the Glacial period, but no one knows how much. The corals of reefs that had grown in Preglacial time on the northern and southern borders of the coral zone, as around the Hawaiian islands, were presumably killed; but it is impossible to say, *a priori,* whether the corals were killed through the middle of the torrid coral zone as well. Dead reefs must have been attacked by the sea below their crown, but who can say how far they were cut away? Live reefs would not

have been cut away. Additional factors are introduced by the complexity of the Glacial period, for it includes several Glacial epochs of different intensities separated by Interglacial epochs of different durations; and no one yet knows how to date the history of coral-reef islands in terms of Glacial chronology. The quantities involved in the Glacial-control theory are therefore of uncertain value.

Uncertainties of the Glacial-Control Theory.—There are two other groups of uncertainties in the Glacial-control theory, as it has thus far been set forth. The first arises from the improbable nature of one of its fundamental postulates; the second, from the over-long series of deductive steps—not always sharply defined—for which no sufficient verification has been provided by confronting them with observable facts. The improbable fundamental postulate is that the ocean bottom did not subside in the coral-reef region for a long period of Preglacial and Glacial time. No reasons are offered in support of this singular assumption; yet it is held to be so true that ancient volcanic islands, possibly formed as long ago as in Paleozoic time, are believed to have suffered flat truncation by erosion and abrasion, down to or a little below sea level, and that the flat surface of truncation remained close to sea level, without subsidence, until the Glacial period! Is it not venturesome to give subsidence the special value of zero for so long a time in the coral-reef region of an ocean, the bottom of which has suffered repeated elevations, as shown by uplifted coral reefs, and has suffered, in its Australasian area, demonstrable deformation, with many ups and downs, as shown by the isolated remains of former continental lands? And is it really necessary to make subsidence zero for a long time and over a large area in a theory in which the occurrence of subsidence now and again at a slow rate or by starts and stops is not at all incompatible with the various processes of Glacial control, even though it would affect the value of their results? Yet as stated by the latest expositor of the Glacial-control theory, this unnecessary and venturesome postulate is practically insisted upon, and the theory is therein made to resemble the several other theories that arbitrarily postulate still-standing islands, and thus place themselves in opposition to Darwin's more general theory of subsidence: "more general," because subsidence can have all grades of value from its maximum down to zero, and because prevailing subsidence may be interrupted by still-stand pauses or even temporarily reversed into uplift, as Darwin clearly stated; but still-stand theories are based on a rigidly fixed postulate of immobility, as far as subsidence is concerned.

Among the unverified deductive steps in the Glacial-control theory, we may note in particular the Preglacial truncation of numerous still-standing volcanic islands at sea level or a little lower; the Preglacial formation of numerous marginal reefs by outward growth on an ad-

vancing talus of coral débris around still-standing truncated flats or shoals; the reduction of ocean-surface temperature in the coral zone during the Glacial period sufficiently to kill the corals of nearly all reefs; the complete abrasion of even the broadest atolls during the lowered sea-stands of the Glacial period; the uncomformable upgrowth of new atoll reefs on the abraded platform of low Preglacial islands as the sea rises; and again, the Preglacial formation of outgrowing encircling reefs around younger, mountainous, still-standing, non-embayed volcanic islands; the reduction of these reefs to platforms by abrasion during the lowered sea-stands, but without significant encroachment upon their central islands; the erosion of the deeper parts of the central-island valleys, now drowned in embayments, during the lower sea-stands of the Glacial period, but to no greater depth than the level of the lowered sea; the sufficient widening of the deepened valleys by the slow process of valley-side weathering during the lowered sea-stands, so that, when drowned, the valleys shall contain the well-opened embayments now visible; and the unconformable upgrowth of new barrier reefs on the abraded platforms with the rise of the sea.

No sufficient verification is provided for this elaborate series of deductions. Not a single example of a truncated volcano is known in the coral seas. Not a single example of a recently uplifted atoll is known to have an abraded volcanic area in the center of its lagoon-plain. Not a single example of an uplifted atoll is known to consist in its underpart of the steeply inclined talus layers composed chiefly of coral débris, such as must here be supposed for the great undermass. Not a single example of a recently uplifted atoll or barrier reef is known in which the reef wall stands unconformably on a flat platform abraded across a series of slanting talus layers largely formed of coral débris, as must be the case under the Glacial-control theory. True, an attempted verification of the abrasion of Preglacial atolls during the lowered sea-stands of the Glacial period has been offered in a table of the depths of atoll lagoons; but the measures of depth show no such accordance as the theory demands. The maximum depths of the lagoons vary through a large fraction of the supposed depth of the abraded platform; the mean depth of the deeper parts shows a similar variation. Such inconstancy of lagoon depth can be explained only by supposing that the atoll platforms were abraded at various levels, for which no good reason is assigned; or by supposing that the platforms, after being abraded at a uniform depth, have been irregularly covered by Postglacial lagoon deposits. The latter supposition is extremely probable, as far as the occurrence of lagoon deposits is concerned; but if accepted it leaves the platforms without verification. It may be truly said, in reply to this and the preceding paragraph, that all theories of coral reefs, the subsidence theory as well as the rest, involve unverified deductions; but as far as I

can see, the subsidence theory is less deficient in this respect than any other.

In view of the insufficient attention that, as thus appears, has been addressed to the matter of confrontation and verification in the Glacial control theory, in the form in which it has thus far been set forth, it seems desirable to give closer examination to that phase of the problem; not with the intention of making up the deficiencies in the statements of its expositors, for that is their own affair; but with the wish of finding for oneself definite grounds which shall warrant a decision in favor of the theory or against it; for it is the duty of every investigator to make himself personally responsible for the critical discussion of every theory that has been offered in solution of his problem; he must not

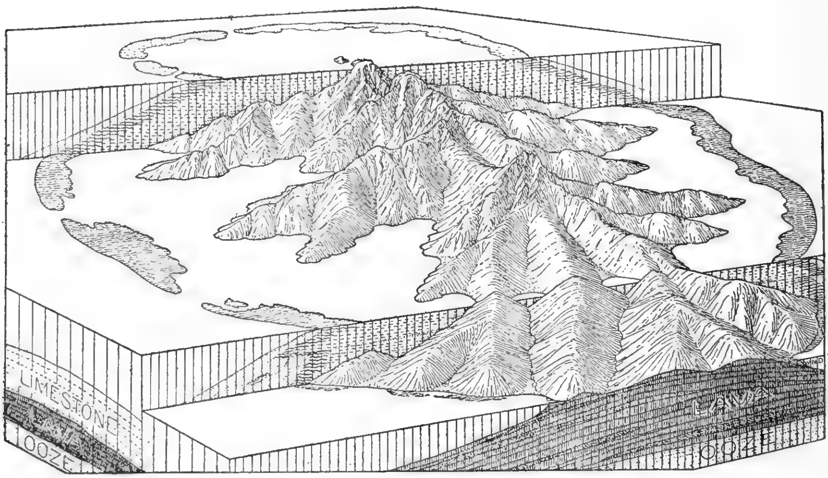

FIG. 30. BLOCK DIAGRAM OF A STILL-STANDING VOLCANIC ISLAND IN A RISING OCEAN. In the narrow foreground block, the island has a simple shore line with a discontinuous fringing reef; in the middle block, the rising ocean has half-submerged the island, giving it an elaborately embayed shore line, and the fringing reef has developed into a barrier reef by up-growth; in the background block, the rising ocean has almost submerged the central island, and the barrier reef has almost become an atoll. The first up-growth of the fringing reef, as shown on the front face of the middle block, is drawn nearly vertical, because the amount of waste taken from it to form its short external talus was then small: the effect of a pause in the rise of the ocean is shown in the horizontal out-growth at mid-height in this section. The later up-growth of the barrier reef, as shown on the front face of the background block, is drawn inclining inward, because a large amount of reef waste is needed to form the greatly prolonged talus, which now begins at a greater height and must extend down nearer the base of the volcanic cone. Compare this figure with Fig. 16.

throw off that responsibility, or leave it wholly to the inventors of other theories than the one to which his judgment inclines. The first step to be taken in meeting this responsibility with regard to the Glacial-control theory is to define more sharply certain consequences to which it leads; and in doing so it might be well, as above intimated, to give special attention to reefs near the border of the coral-reef zone; but as the

only reefs so located that I visited were on Oahu in Hawaii and along the coast of Queensland in Australia, this method of testing the theory will not be pursued for the present. The reefs of the torrid zone, of which I saw more abundant examples, will be examined instead; and for this purpose several tentative assumptions will be made, from each of which certain essential consequences will be deduced, in order to confront them with the facts.

Special Consequences of the Glacial-Control Theory.—For example, sector *E,* Fig. 31, represents a rather narrow Preglacial reef plain,

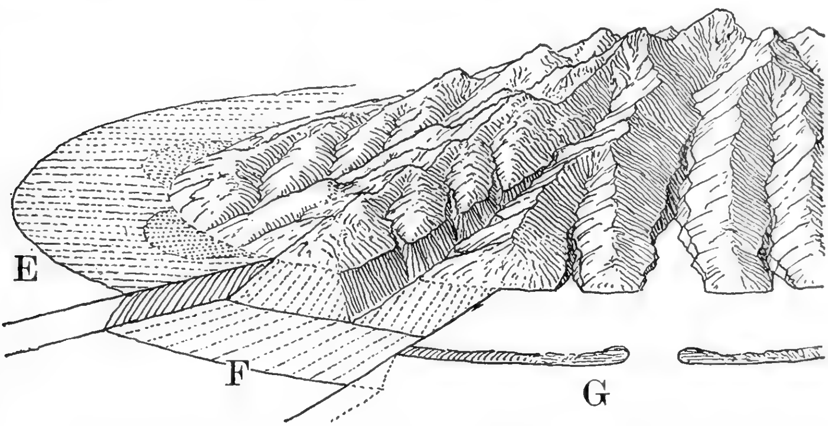

FIG. 31, DIAGRAM OF SUCCESSIVE STAGES OF REEF FORMATION, as deduced from the Glacial-control theory, on the supposition of a relatively short period of lowered ocean level.

with no lagoon, bordering a dissected, still-standing volcanic island of non-embayed shoreline and salient deltas. In sector *F,* we see the abraded platform cut by the waves of a lowered and chilled ocean, which did not, however, work long enough to becliff the volcanic island; and also a young valley incised with reference to the lowered sea level in the floor of a Preglacial valley. In sector *G,* the sea has risen and warmed, a barrier reef has been built up enclosing a lagoon, and the young valley is embayed. A detailed consequence of these changes is an "edge" where the steep walls of the young valley cut the gentler side-slopes of the Preglacial valley; this edge ought to begin close to sea level on either side of the new embayment near the former margin of the island, and gradually ascend inland beyond the embayment to the head of the young valley. No such edges, no such "valley-in-valley" forms were found in any one of the hundreds of partly drowned valleys that I saw in the Pacific; hence a second assumption must be tried. Sector *E,* Fig. 32, shows the Preglacial condition again; sector *F* represents the work accomplished during a longer time of lowered sea level than before, a time long enough to allow the widening of the new-cut valleys so that

all trace of the Preglacial valleys should vanish, even to their heads; but in so long a time as that, the sea would surely cut away not only all the Preglacial reef-plain, but part of the volcanic island as well; then, after the sea rises as in sector *G*, the spur ends between the wide embayments should be truncated, and the steep faces of their cliffs would plunge below sea-level. Cliffs of this kind ought to be specially well developed around the younger volcanic islands, which in Preglacial times had only narrow fringing reefs or no reefs.

But spur-end cliffs do not occur on such islands: hence the corals of their reefs cannot have been killed. Perhaps the drowned spur-end cliffs of Tahiti, figured above, are the work of abrasion during the lowered sea-stands of the Glacial period; but if they are, Tahiti is of so ex-

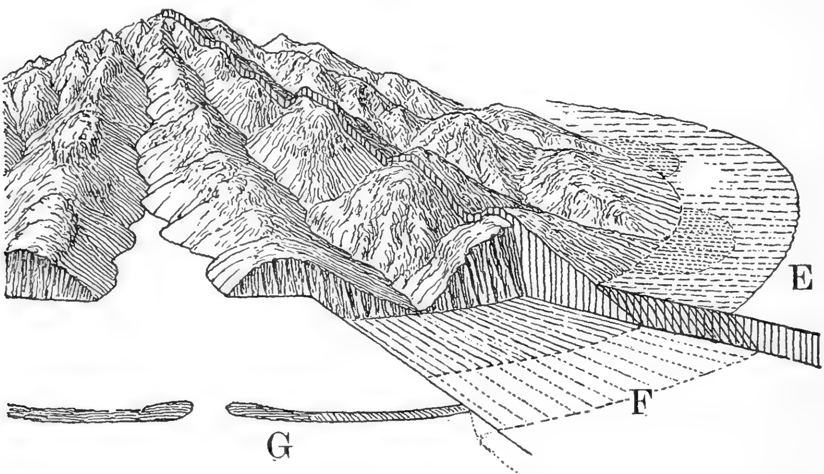

FIG. 32. DIAGRAM OF SUCCESSIVE STAGES OF REEF FORMATION, as deduced from the glacial-control theory, on the supposition of a relatively long period of lowered ocean level.

ceptional a form in this respect that its cliffs prove too much for other islands. The spur ends in the other members of the Society group and elsewhere are as a rule not cut off in cliffs; or if a little becliffed, a shallow platform extends forward from the cliff base, showing that the cliff has been recently cut at present sea level. Hence in order to explain the prevalently tapering forms of non-cliffed or little cliffed spurs, it must be supposed that the corals of their enclosing reefs were not killed while the sea was lowered, and thus an essential half of the Glacial-control theory, as it has been recently propounded, is excluded.

However, even if the corals were not killed and the reefs were not cut away, the valleys of the central islands must have been deepened while their streams ran down to a lowered sea level. But is it reasonable to suppose that the lowered sea level of the Glacial period en-

dured long enough to allow not alone the incision of narrow valleys by small streams, but also the widening of the valleys by slow weathering to the observed width of the actual embayments, some of which are one or two miles across? The simplest test I have found for this question lies in a comparison of the drowned-valley embayments of the volcanic islands in the Pacific with the valleys of certain dissected volcanoes in central France. According to French observers, those volcanoes are of Preglacial origin, and they have suffered glaciation more than once; but their valleys, even where enlarged by glacial erosion, have not consumed so much of their initial form as has been consumed in the embayments of Tahaa or of Borabora in the Society group, or of Ka-ndá-vu in the Fiji group, or of Rarotonga in the Cook group, or of Oahu in Hawaii; nor so much as has been consumed in the embayments of New Caledonia or of Queensland, which consist of continental, not of volcanic rocks. The valleys of the embayments in these islands are too wide to have been cut during so relatively short a time as the Glacial period; hence I am driven to think that the processes of the Glacial-control theory, acting alone, are incompetent to produce the observed results. Nevertheless the level of the sea must have been lowered during each epoch of the Glacial period, and must have risen in each Interglacial epoch as well as in the present Postglacial epoch. How can these undeniable changes be best included in a general theory of coral reefs?

Combination of Subsidence and Glacial Control.—The element of the Glacial-control theory which seems to me least reasonable is the postulate of still-standing reef foundations. Fortunately that postulate is unessential. Let us therefore see whether the Glacial-control processes and the subsidence processes cannot work harmoniously

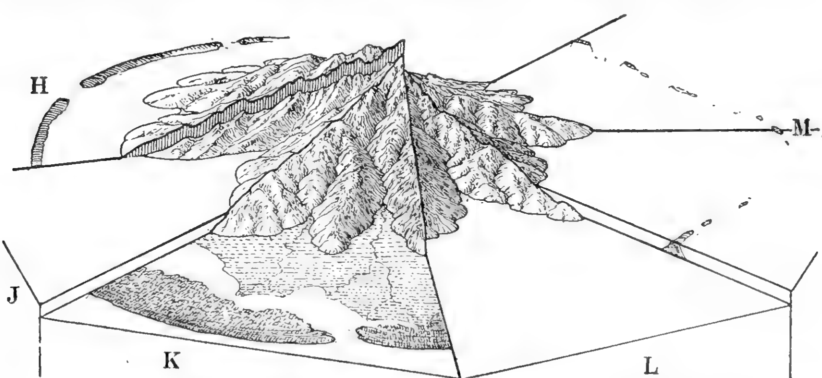

FIG. 33. DIAGRAM OF SUCCESSIVE STAGES OF REEF FORMATION, as deduced from a combination of the glacial-control theory with Darwin's theory of up-growth during subsidence.

together. Sector *H*, Fig. 33, represents a barrier reef developed during Preglacial subsidence in a region where Glacial cooling, when it comes,

shall not be sufficient to kill the corals. Sector *J* shows the effect of continued subsidence without upgrowth in an unchanging ocean. Sector *K* shows the effect of neutralizing subsidence by the contemporaneous lowering of the ocean surface as the ocean water is withdrawn to form continental ice sheets; that is, if the island sinks at about the rate that the ocean is lowered, a relative still-stand is the result for the time being; and during a long enough still-stand a broad and mature reef plain will be developed by the outgrowth of the reef itself, by the inwash of its waste, and by the forward growth of deltas which will fill the former embayments and advance into the lagoon, as in Sector *K*. Now if subsidence continue during a maximum of glaciation, a critical condition will be reached when the ice sheets begin to melt and the ocean begins to rise, as in sector L, for the joint effect of ocean rise and subsidence will be a doubly rapid submergence, sector *M*, as a result of which the upgrowth of the reef may not keep pace with the rise of sea level, and the reef may become discontinuous; its renewed growth may even be stopped if it is "drowned" by too rapid submergence. Perhaps the discontinuity of certain reefs that rise, as has recently been pointed out, from submerged platforms, but not necessarily on their outer edge, may be explained in this way. In any case, I believe that some combination of regional subsidence with Glacial changes of sea level—or with changes of sea level caused by movements of the sea bottom—is worthy of careful consideration as being probably nearer the truth than either process taken alone: but of the several processes, subsidence in the coral-reef areas seems to me to have acted through a longer time and to have played by far the greater part in the development of coral reefs.

Other Hypotheses Regarding Coral Reefs.—Various other hypotheses have been proposed to account for coral reefs. Some of the early explorers explained reefs as determined by the instinct of the "coral insects"; others regarded them as built upon the rims of submarine craters; one long-practised student of the problem in more recent years suggested that an extensive system of barrier reefs near one of the larger Fiji islands may have grown up, independently of subsidence, from submarine lava flows; an observer in Samoa suggested that certain reefs in that island group have been determined by submarine hot springs; a widely experienced traveller in the Pacific suggested that many atoll-reefs are of small thickness, formed around uplifted and worn-down limestone masses of unexplained origin; a less experienced observer accounts for the outline of atolls largely by the action of wind-driven waves. These suggestions all represent conceivable possibilities; but they are not supported by sufficient evidence to show that they correspond to geological realities. The first of the six hypotheses is only a relic of an earlier philosophy; the second was generally accepted

till Darwin showed its impossibility; the third entirely overlooks the shore-line evidence of strong submergence following submature dissection; the fourth hypothesis makes the gratuitous assumption that submarine hot springs exist in requisite number and position; the fifth hypothesis includes no adequate explanation of the assumed limestone masses, although, where little dissected remnants of such masses are found, they have every appearance of being atolls of an earlier date; the sixth hypothesis exaggerates the action of a true cause, for it overlooks the usually concentric arrangement of central islands within their barrier reefs, as shown in Fig. 19; this arrangement demonstrates the action of winds and waves to be of secondary importance in determining reef outlines. Need these hypotheses be further considered?

Conclusion.—To what conclusion is an inquirer led by this study of coral reefs? At least to the certain conclusion that the origin of coral reefs, like the origin of many other geological features, is not susceptible of absolute demonstration. All that can be hoped for in problems relating to the past origin of present features, such as synclinal ridges in mountains of folded structure, hanging lateral valleys in formerly glaciated mountains, "faulted" strata, "metamorphosed" rocks, and coral reefs, is a highly probable explanation. It is true that geologists are accustomed to regard various highly probable explanations as having the same order of verity as directly observed facts: for who doubts that faulted strata, for example, have been displaced from their original continuity, or that fossils are of organic origin? Nevertheless, these universally accepted conclusions are nothing more than highly probable inferences. Why, then, are they universally accepted? Because the experience of many geologists through many years in many places gives every reason to accept them as correct, and as yet no reason to reject them.

No theory of coral reefs at present reaches so high a degree of probable correctness as to be universally accepted. It is true that most geologists of fifty or sixty years ago thought the coral-reef problem was fully explained by Darwin's theory of upgrowth during subsidence; but geological thought at that time was not so critical as it is now regarding the acceptance of hypotheses; and moreover the problem of coral reefs had not then been enriched by the invention of several alternative hypotheses. There was at that time practically only one theory of coral reefs before geologists worthy of consideration; it explained the things that it had been invented to explain, and that was deemed sufficient to ensure its correctness and to warrant its acceptance. In the last thirty-five years certain additional theories of coral reefs have been brought forward, all the theories have been subjected to closer scrutiny than before, and one or another of them has been accepted with more or less confidence by a less or greater number of geologists; but the majority of geologists,

disconcerted from the confident belief in Darwin's theory of subsidence that formerly prevailed, and demanding strong evidence before they accept any one of the several current theories, now have no definite views in the matter: they learn that the problem is "unsettled"; they have no opportunity of studying coral reefs themselves, and as a rule not time or inclination enough to make a close study of the work of those who have studied coral reefs. Such is the uncertain condition of the problem to-day. In view of this and as a summary of the fuller discussion on the preceding pages, the present writer offers the following statement of his own opinion regarding the several current theories as the result of much reading, observation, discussion and reflection during the past two years.

The origin of barrier reefs and atolls on still-standing islands more or less completely truncated by marine abrasion is contradicted by the features of the islands within barrier reefs and by the structure of uplifted reefs. The resurrection of this theory in recent years, after it had been shown by Darwin over 70 years ago to be incompetent as an explanation of barrier reefs, has not advanced the solution of the coral-reef problem.

The origin of atolls by upward and outward growth on still-standing submarine foundations capped with pelagic deposits is a manifest possibility, but it is not confirmed by any independent evidence. The theory is unfortunately limited by the unnecessary postulate of still-standing foundations. If this limitation be relaxed, and if, in view of the common occurrence of uplifted reefs in various parts of the Pacific, uplift is supposed to take place at a rate a little faster than the downward erosion of the uplifted mass and a little slower than the outward growth of the fringing reef, a conical coral island would result; the cone would be terraced if the uplift were intermittent; as erosion progressed, a volcanic nucleus would be disclosed. No such conical coral islands are known; hence uplift at the rate here suggested cannot have been commonly associated with the formation of atolls. But uplifted and little dissected atolls occur not infrequently as tabular islands; they show that rapid uplift sometimes occurs after the construction of an atoll is well advanced. Uplift therefore seems, when it acts, to be a more effective process than upbuilding.

If, on the other hand, in view of abundant evidence of subsidence that is found especially in the western part of the Pacific coral-reef area, intermittent subsidence is considered in association with the up- and out-growth theory of atolls, then this theory merges into Darwin's theory. If both uplift and subsidence are considered, it is evident that uplift is most favorable in the early stages and subsidence in the later stages of the process; for subsidence in the early stages would as a rule prevent the effective upbuilding of a submarine summit

by a pelagic capping, and uplift in the later stages would prevent the formation of normal atolls. Since normal atolls are to be counted by scores or hundreds, it seems, when all reasonable factors in their formation are considered, extremely improbable that many of them have been formed on submarine volcanoes that grew by eruption near enough the surface to be further built up to the coral limit by a pelagic capping, but did not grow by eruption above the ocean surface sufficiently to form enduring islands, and that, after their eruptive building had ceased, always stood still and never subsided. Indeed it would require extraordinary unanimity among pelagic volcanoes, in an ocean in which recent and subrecent eruptions are so numerous and in which signs of recent uplift and subsidence are so widespread and abundant, to build up a series of lofty cones from the deep ocean bottom, scores of which should approach close to the surface in regions now occupied by atolls, but none of which should form islands originally large enough to be still visible although much worn down, and none of which should suffer elevation or depression!

If more facts were known about atoll structures, some of the supposed possibilities above noted might be excluded; but as long as observation is limited to the surface reefs of atoll rings, their origin must remain a matter of speculation. Yet in view of what is known of other coral islands, the most reasonable result of speculation today must include subsidence as a factor in the making of many or most atolls.

The outgrowth of barrier reefs around still-standing islands, the excavation of their lagoons by solution, and the conversion of the barriers into atolls by the erosion and abrasion of their central islands is easily conceivable; but observation shows that lagoons are the seat of deposition, not of solution; no example of the almost-atoll stage, in which the central island of a barrier reef is reduced to a lowland with an alluvial rim, is known. The rigid fundamental postulate of still-standing reef foundations is contradicted by abundant evidence of changes of level, by the structure of certain uplifted reefs, and by the eroded surface of the volcanic or other rocks on which uplifted reefs rest. If the rigidity of this postulate is relaxed, and subsidence is allowed as demanded by various lines of evidence, a lagoon will be formed without the aid of solution, and the still-stand theory will be transformed into Darwin's theory.

The modification of the theory of outgrowth on still-standing foundations by the processes of the Glacial-control theory appears to be based on true factors, but unfortunately the quantitative value of these factors is unknown. The theory is ingeniously developed through a long series of deduced consequences, but it is arbitrarily limited by the unessential postulate of still-standing reef-foundations in the coral-reef region during a long period of time, and many of its consequences are,

as above noted, not confirmed by observation. The moderate abrasion of narrow-lagoon barrier reefs is, I believe, incompatible with the broad abrasion of large atolls; hence the corals of most reefs were not killed in the Glacial period. Many now-embayed valleys in barrier-reef islands are, as well as I can estimate, too wide to have been eroded during the Glacial period; hence their erosion must have been well begun at an earlier date when the islands stood at a greater altitude, from which they have since subsided. Thus the Glacial-control theory appears inadequate. If the unessential postulate of still-standing islands is omitted from the theory and the processes of Glacial-control are combined with those of Darwin's theory, as they well may be, the combination is a helpful one, especially along the margins of the coral zone.

It has been pointed out that all the consequences of Darwin's theory of upgrowth during subsidence may be accounted for by a contrasted theory, in which subsiding islands in an unchanging ocean are replaced by fixed islands in a rising ocean. It is entirely possible, nay, highly probable, that such replacement may have sometimes occurred; but it is extremely improbable that the replacement should be complete, for the following reasons. A moderate rise of ocean level over fixed coral-reef islands demands a great rise of a small part of the ocean bottom, or a moderate rise of a great part of the ocean bottom, always excepting the part where the fixed coral-reef islands stand; it demands also various movements of such other islands and continental borders as do not suffer submergence equally with the still-standing coral-reef islands: hence if the rising-ocean theory is to explain all coral reefs, it must demand that much or most of the earth's crust shall long be mobile, while the crust beneath the coral-reef islands must as long remain fixed. Such a demand is too absurd to be accepted. Moreover, if the rest of the earth's crust is so mobile, part of the ocean bottom outside of the fixed coral-reef region may sometimes sink, and the consequent lowering of the ocean's surface would be universally unfavorable to reef formation. Hence the rising-ocean theory can not be accepted as accounting for all coral reefs, and the part that it has played in accounting for any part of them must long remain uncertain. The uncertainty attending this theory is, indeed, so great that the theory is in danger of being discredited thereby: yet by nothing less than a world-wide observational study of coast lines can the uncertainty be resolved.

Darwin's theory of upgrowth during subsidence is not based on the rigid postulate of fixed reef foundations, but on the elastic postulate of a mobile earth's crust. It regards areas of subsidence as the most favorable for the growth of barrier reefs and atolls; it explicitly takes account of a possible variation in the amount of subsidence from place to place, and it as explicitly includes possible still-stand pauses and occasional moderate uplifts as interruptions in a prevailing subsidence.

Its processes are in no way inconsistent with those of the Glacial-control theory, for the two may be combined; its inferences as to extensive areas of ocean-bottom subsidence may be modified as new facts demand, without in the least invalidating its general value. True, the subsidence that it demands in certain areas is apparently to be measured in thousands of feet, and this seems formidable; yet objections to this demand are based much more on our ignorance than on our knowledge regarding the dynamics of the ocean floor. Hence Darwin's theory provides more general and more probable fundamental conditions for its following processes than are provided by any other theory. Furthermore, as far as present observation in the Pacific goes, nearly all the deduced consequences of the theory of upgrowth during subsidence are confirmed: unconformable contact of limestones in uplifted reefs on an eroded insular or continental foundation, instead of on a non-eroded foundation as is required by all the still-stand theories; observed or reasonably inferred large thickness of certain elevated reefs, instead of small thickness as required by the veneer theory; horizontal structure and rarity of fossil corals in the inner part of uplifted reef masses, instead of inclined structure and abundant fossil corals as the still-stand theories demand; embayed central islands within barrier reefs, the embayments being of such width and depth as no other but the very improbable rising-ocean theory can account for; steep but not becliffed islands of small size in the large lagoons of such barrier reefs as have almost reached the atoll stage; and lagoons of various depths, floored with accumulating deposits. So successful a confrontation of deduced consequences with observed facts is certainly very appealing.

Such is the array of evidence that has led me to regard Darwin's theory of upgrowing reefs on subsiding foundations as not only the most acceptable theory of coral reefs yet invented, but as with high probability the dominantly true theory of coral reefs. It is probably destined to be modified in subordinate measure as new facts come to light, and many new facts are without question still to be discovered; but it seems also destined to stand as the leading theory, even when thus modified. I therefore believe that Darwin's theory of subsidence will regain in this century the general acceptance it enjoyed through the middle of the last; and that the several alternative theories, which have found more or less favor in the last thirty or forty years, will be given minor rank or discarded altogether.

Retrospect.—The work of four men was often in mind during my Pacific voyage: Darwin and Dana of an earlier generation, Agassiz and Shaler of our own times. Nathaniel Southgate Shaler, my first teacher in geology, always my best friend at Harvard, the man who opened opportunity to me, who gave me encouragement and support when both were much needed, a man of ever-widening relations with his fellows,

in whose memory my journey across the Pacific is only one of many journeys that will be undertaken as the years pass. Alexander Agassiz, a man of varied and vast achievement, who saw and studied a greater number of coral reefs than any other scientific observer, and who gave all of us the great example of working untiringly to the end; but a man of so reserved a disposition that few of his associates knew him intimately. It is always a regret that my aquaintance with him was slight, and still more that I can not accept the conclusions to which he was led by his many journeys in coral seas.

Darwin and Dana, explorers of the Pacific nearly a century ago. How deep is the impress of these two men on the coral-reef problem! How inevitable is the mention of their names whenever coral reefs are discussed! But we must not picture the Darwin of coral-reef fame as a venerable old man, whose face, although wearied by work through long years of ill health, was always so patient and benign; nor yet as a man of middle age, who, steadfast against a flood of prejudiced criticism, opened new fields for thought and changed the philosophy of an unwilling world; but as a diffident youth, who, when some one was wanted to do scientific work on a long sea voyage eighty years ago, offered his inexperienced services for what they were worth, and yet carried with him such a fund of original thought that, while still in South America, he invented the best of all coral-reef theories before he had ever seen a true coral reef. And the Dana, who, younger than Darwin by four years to a day, followed him across the oceans, was not the grand figure who was still with us, so bravely alert in well-conserved erectitude, hardly more than a score of years ago; nor yet the man in middle life who, setting us all a measure of industrious versatility that none can now attain, standardized three branches of science in America; but a young man, little taught, yet studious and observant, who standing thoughtful on a mountain peak not in Darien but Tahiti, first learned a deep secret of the Pacific, and added to Darwin's theory of coral reefs the confirmation that even Darwin himself overlooked!

The Pacific still has many prizes for the observant explorer. Let the student who would discover some of them note the good example set by Darwin and Dana, and cross the great ocean early in his life, while he is yet young enough to have, after his return from its inspiration, many years for work; but if he finds it impossible to go early, better late than never!

SHAKESPEARE, THE OBSERVER OF NATURE

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OF Shakespeare's life, his personal habits, his ways of playing and working; with whom he was intimate and of his journeyings, we know little or nothing. But a host of editors, commentators, and essayists have examined all the minutiæ of his environment, the plots, characters, and language of his works; much of it repeatedly. One is reminded by this diligence of the methods employed by the prefect's agents in Poe's tale of "The Purloined Letter." "Shakesperiana," as a result of all this research, far outstrips, in quantity at least, the literature which has thus far in the world's history ever accumulated about any other man and his work. Poor Will, should he awake to-day, and should he undertake the heroic task of editing all these writings, what a blue pencilling of pretty volumes there would be!

Yet this tangle of speculation and criticism, though full of weak and knotted strands, is in the main a literature we prize. While, therefore, it is difficult to find a Shakesperian theme that has not been interestingly and exhaustively discussed it does seem that the great writer's nature observations are worthy of a fuller treatment than has hitherto been accorded them. In the following paragraphs some attempt is made to show the range of subjects these cover, and their surprising accuracy in view of the crude state of scientific knowledge in Shakespeare's time.

Manners and customs change, and with them human points of view. By the inventions of three hundred years our social environment has been greatly altered. Yet the rich legacy bequeathed us by that grandest age of English literature, the sixteenth century, has enabled us to image Elizabeth's court and country with a degree of accuracy that is impossible with other remote periods in the history of modern civilization. But as some of the details in the picture, some of the essentials even, lack confirmation, our inferences may often be in error. Man varies his standards of conduct from year to year, but nature is a more staid dame—although she too changes her garb with the seasons, the cut and the cloth of the dress she assumes in each remains the same through the centuries. Thus the climate of Great Britain, the contour of her hills and vales are now as they were in Shakespeare's time. The same trees grow in the forests, among their branches flutter the same birds, on the forest-floor bloom the identical wild flowers that the poet's eye loved to dwell upon. If then we study the poet's nature lines and draw con-

clusions from them, we may be sure at least that the outdoor world has much the same aspect as it had in his day.

Editors in general express their amazement at Shakespeare's wonderful and accurate knowledge in natural science. Yet it is doubtful whether they collectively appreciate how wonderful this really was. They compare Shakespeare's observations with those of modern scientists and note that these agree. They judge Shakespeare's natural history in the same manner that they would that of a modern novelist and find it more than simply trustworthy. What this means can only be made apparent by an inquiry into the degree of progress in natural science that had been made up to his time.

Extremely curious fallacies were entertained and accepted by Shakepeare's scientific contemporaries, to say naught of the popular beliefs. Comparison of Shakespeare's observations with those which obtained in the published natural histories of his day enables us to realize how far he was in advance of the authors of such books. One such volume is Bartholomew's "De Proprietatibus Rerum," of which Mr. H. W. Seager, an English writer, says:

> There can be no doubt that Friar Bartholomew's book was the standard authority on natural history in Shakespeare's time.

From Batman's translation of Bartholomew is quoted the following description of bees and their habits:

> Many have assayed and found that often bees are gendered and come of carrions of cattle. . . . And bees choose to their king him that is most worthy and noble in kindness and firmness, and most clear in mildness, for that is chief virtue in a king. . . . And kindly the more huge bees are the more lighter they be for the greater bees be lighter than the less bees. . . . Also bees sit upon the hives and suck the superfluity that is in honeycombs. And it is said that if they did not do so thereof should spiders be gendered of that superfluity and the bees should die.

Next consider Shakespeare's version:

> For so work the honey bees,
> Creatures that by a rule in nature teach
> The act of order to a peopled kingdom.
> They have a king and officers of sorts;
> Where some, like magistrates correct at home,
> Others, like merchants, venture trade abroad,
> Others, like soldiers, armed in their stings,
> Make boot upon the summer's velvet buds;
> Which pillage they with merry march bring home
> To the tent-royal of their emperor;
> Who, busied in his majesty, surveys
> The singing masons building roofs of gold
> The civil citizens kneading up the honey,
> The poor mechanic porters crowding in

Their heavy burdens at his narrow gate,
The sad-ey'd justice, with his surly hum,
Delivering o'er to executors pale
The lazy yawning drone.
—"Henry V.," Act I., s. 2, l. 187 et seq.

While this poetical account may not be wholly in accord with the observations of a Fabre, yet the whole description is sane, it is in no sense outré. If Shakespeare gives us so faithful an account in verse, where he is entitled to a poet's license in dealing with the facts, how accurate an interpreter he must have been; since he had to rely necessarily on his own observations for all such descriptions; contemporary natural science abounding in the grotesque vagaries cited above.

The country about Stratford-on-Avon was Shakespeare's haunt until his twenty-first year. Warwickshire, in which Stratford-on-Avon is located, is in the English Midlands. Of these the Avon district is notable for its soft, reposeful beauty. Every aspect has the appearance of being well rounded off, of being well fed. The land is a series of lowlying plains, separated by rolling hills, its surface suggesting that of a summer sea undulating in gentle swells. Through the lowest vale creeps the Avon water, whose slow advance along shore is all but stopped by the soft friction of the earth margin. In such quiet reaches extensive tracts of bulrushes grow luxuriantly. A fringe of yellow water-lillies generally marks the outer edge of this growth while on the shore side the green meadow grass bends down to meet the water. Where the banks are a bit higher the rich alluvial soil sustains a wealth of beautiful wild flowers. Shakespeare himself has described the stream for us:

The current that with gentle murmur glides,
Thou know'st, being stopped, impatiently doth rage;
But when his fair course is not hindered,
He makes sweet music with th' enamell'd stones,
Giving a gentle kiss to every sedge
He overtaketh in his pilgrimage.
And by so many winding nooks he strays
With willing sport to the wild ocean.
—"T. G. of V.," Act II., s. 7, l. 25 et seq.

To any one who has looked through the clear waters of some slow-flowing stream to its pebbled bottom, at a point where it tinkles with swifter motion over some slight descent, the application of the adjective "enamelled" must be fascinating. With a single word, Shakespeare images a page of description.

From the shores of Avon the land rises on both sides in gentle sweeps to the uplands, of which both the slopes and summits are dotted with stately clumps of oak and ash, the remnants of a once great forest. In Shakespeare's time, contemporary authors tell us, quite extensive tracts yet remained standing. The uplands from which the timber has

been cut are just high enough to be breezy, and from their ridges one commands quite a view of the surrounding country.

Amid such pleasant scenes Shakespeare's boyhood and youth was spent. Undoubtedly he had all a boy's love of sport, and with his school companions enjoyed many an outing in the woods and fields. On these outings he applied to natural phenomena the same intelligent observation, linked with imagination, that he was to apply so effectively in later life to men and events. As a boy and youth Shakespeare gained his nature lore, and acquired also the scientist's painstaking method of investigation. It must not be inferred from this that Shakespeare parted from nature for all time, when, at twenty-one, he rode away to London. But many of his observations are so essentially boyish, they exhibit so plainly the boy's point of view, that we can not mistake the time when these brain impressions were made. Experiences creep ever and anon into his writings that are curiously part of the career of a healthy-minded youngster rambling on half holidays through Warwickshire woodlands, and beside the Avon water. He tells us:

> Men like butterflies
> Show not their mealy wings but to the summer.
> —"Troilus and Cressida," A. III., s. 3, l. 78–9.

We all know of this *mealiness,* but we feel that it was never the observation of a grown man. Only the boy, whose thumb and forefinger have closed on the struggling captive, can duly appreciate the poet's conception. It is a boy too, who invites you:

> I prythee, let me bring thee where crabs grow;
> And I with my long nails will dig thee pignuts;
> Show thee a jay's nest and instruct thee how
> To snare the nimble marmozet; I'll bring thee
> To clust'ring filberts and sometimes I'll get thee
> Young scamels from the rock. Wilt thou go with me?
> —"Tempest," A. II., s. 2, l. 171 et seq.

No one could resist such an invitation. Again it is possible that the deer-stealer of later fame is foreshadowed in the youthful poacher who knew

> The trout that must be caught with tickling.
> —"Twelfth Night," Act II., s. 5, l. 25–6.

Other passages charmingly present the boy. We can not do better than suppose ourselves permitted to accompany the poet and a party of his schoolboy friends, out for an all-day ramble. According to agreement, we meet early.

> The lark at break of day arising
> From sullen earth, sings hymns at heaven's gate.
> —Sonnet XXIX.

and

> The busy day
> Wak'd by the lark, hath rous'd the ribald crows.
> —"T. and C.," A. IV., s. 2, l. 8 et seq.

for these the

> Merry larks are ploughmen's clocks.
> —"L. L. L.," A. V., s. 2, l. 912.

and to their music we wend our way through

> The quaint mazes in the wanton green

past the

> Nine-men's morris.
> —"M. N. D.," A. II., s. 1, l. 99, 98.

to the edge of the village common. We avoid the highway, choosing, instead, to follow one of those byways for which England is famous; byways that respect no man's vested right, but cross the midst of fields and turn not aside at the hedge of a private park, for they assert emphatically, as one writer has put it:

> That although the land is yours when you buy it, the outlook from every point belongs to the people, and can not be bought!

In the dewy grass beside the path we chance upon a snail and find by experiment that he, his

> Tender horns being hit,
> Shrinks backwards in his shelly cave with pain,
> And there all smother'd up, in shade doth sit,
> Long after fearing to come forth again.
> —"Venus and Adonis," l. 1033 et seq.

Shakespeare's vivid memory of this incident enables him to introduce, without any incongruity, so homely a creature when his theme is love, moreover to use it in a comparison. In "Love's Labour Lost," Berowne declaims

> Love's feeling is more soft and sensible
> Than are the tender horns of cockled snails.
> —A. IV., s. 3, l. 337–8.

When at noon we find that

> The sun shines hot.
> —"H. VI.," Pt. 3, A. IV., s. 8, l. 60.

we turn into the woods where

> The green leaves quiver with the cooling wind
> And make a chequer'd shadow on the ground.
> Under their sweet shade.
> —"T. Andron.," A. II., s. 3, l. 14 et seq.

we loll, while Shakespeare weaves for us a thousand fancies. All too soon

> The sun begins to gild the western sky.
>
> —"T. G. of V.," A. V., s. 1, l. 1.

and we must turn on our homeward way. English twilights are long, and the yellow slanting beams from the low-hung orb of day twinkle and gleam among the path-bordering-trees for hours. In this golden light dance the gnats so fast, so furiously, disappearing so mysteriously, that Shakespeare propounds

> And whither fly the gnats but to the sun?
>
> —"H. VI.," Pt. 3, A. II., s. 6, l. 9.

a query no one of us can answer. In silence we trudge the last few miles while:

> The crickets sing, and man's o'er labour'd sense
> Repairs itself by rest.
>
> —"Cymbeline," A. II., s. 2, l. 11.

It were easy to multiply such pages from Shakespeare's life and the task is a delightful one. One can not fail to be impressed again and again by the acuteness and accuracy of his observations. When one essays to group these references under their different heads, one first realizes how extensive was his acquaintance with nature, animate and inanimate. The animal kingdom he brings oftenest to our attention. All the reptiles which were native to Warwickshire he knew; modern investigators have not been able to add to the number which Shakespeare notes in his poems and plays. In other phases of natural history he was equally well versed; to appreciate this we have only to examine his work systematically.

Alexander Pope declared of Shakespeare that:

> Whatever object of nature . . . he speaks of or describes it is always with competent if not with extensive knowledge; his descriptions are still exact, all his metaphors appropriated and remarkably drawn from the true nature and inherent quality of each subject.

This appreciation applies in its fullest force to Shakespeare's knowledge of birds. In this branch of nature lore he displays, indeed, the most exact and extensive learning. There are several reasons for this. The vale of Avon furnished exceptional incentives for the development of an ornithologist, because of the number of species that could be observed there. Other than the varieties of land-birds which regularly resorted to the meadows and woods of the Warwickshire country, seabirds, driven inland from the coast by heavy southwest gales, followed the course of the Avon as far as Stratford, and remained in that vicinity several days before again winging their way back to the shore. In spring and fall

migratory birds of many kinds halted there during their north and south flights.

Yet the variety of bird life found in Warwickshire only in part accounts for Shakespeare's great birdcraft. A very important factor in its acquisition was the great vogue of falconry in those days.

It is hard for us to conceive how widely popular this sport, now almost obsolete, was at that time. Mr. J. E. Harting, a British ornithologist, writes:

> In Shakespeare's time every one who could afford it kept a hawk, and the rank of the owner was indicated by the species of bird he carried. To a king belonged the gerfalcon; to a prince the falcon gentle, to an earl the peregrine, to a lady, the merlin; to a young squire, the hobby; while a yeoman carried a goshawk; a priest, a sparrowhawk; and knave or servant a kestrel.

A well-trained hawk was as much a source of pride to the falconer as a skillful hunting dog is to the modern sportsman. That Shakespeare was well versed in this pastime is evident from the numerous references to it which occur in his work, and from the number of its technical terms which he employs. Many of these direct allusions to falconry are interesting in themselves.

> As confident as is the falcon's flight
> Against a bird!
>
> —"Rich. II.," A. I., s. 3, l. 61.

he exclaims, and in "King Henry VI." we have the old sportsman's chronic failing, his fondness for patronizing comments—expressed by Cardinal Beaufort:

> Believe me, cousin Gloucester,
> Had not your man put up the fowl so suddenly,
> We had had more sport.
>
> —"H. VI.," Pt. 2, A. II., s. 1, l. 45 et seq.

Similar passages are numerous in fact, the first part of this scene is altogether devoted to falconry talk, and abounds in the jargon of that craft.

As may be inferred, not all birds, to use the parlance of the day, were "flown at," moreover, certain birds were the prerogatives of the great. Among these may be mentioned the heron. This came about partly because such birds afforded better sport; also because the meaner species of hawk, that people of lower rank carried, could not cope to advantage with such large quarry. These restrictions only tended to make the devotee, whate'er his class, more observant of all the birds that came within his view. Such riveting of the attention must have keyed Shakespeare's powers of observation to the highest pitch. Where other falconers may have dismissed the unavailable bird with a glance, he no doubt beguiled his waiting for desired quarry by noting the habits

of those species that had nothing to fear from his hawk. Hunters to-day find game that is out of season most plentiful, and in all likelihood the rule held good in the sixteenth century. Yet it is wonderful how many kinds of birds Shakespeare knew.

He mentions all the species having popular names. We may well infer that he was acquainted with many more, for it must be remembered that Shakespeare was in some degree, no doubt, obliged to confine his allusions to species that were familiar to his audience. Yet he finds occasion to mention the eagle, buzzard, osprey, the different kinds of owls, the pelican, crow, raven and woodpecker, the magpie, jay, thrush, blackbird and bunting, the cuckoo, robin, sparrow and wren, the dove and the partridge. Besides these there are birds distinctively mentioned as flown at, the lapwing, the woodcock and snipe, also wild geese and duck. Of distinctly sea birds the guillemot and the cormorant are cited. The aptness and truth of the references he makes to these denizens of the air shows how conversant he was with their ways. What modern playwright or poet knows half this number of species well enough to use them in his diction?

The lark seems to have been a favorite with Shakespeare. It is mentioned again and again, and almost always associated with the morning.

> Lo! here the gentle lark, weary of rest,
> From his moist cabinet mounts up on high
> And wakes the morning, from whose silver breast
> The sun ariseth in his majesty.
>
> —"Venus and Adonis," l. 853 et seq.

The blackbird he describes as

> . . . so black of hue
> With orange tawny bill.
>
> —"M. N. D.," A. III., s. 1, l. 131–132.

The young of the lapwing "run almost as soon as they are hatched" we are informed by ornithologists, and Shakespeare has noted this peculiarity.

> This lapwing runs away with the shell on his head.
>
> —"Hamlet," A. V., s. 2, l. 193.

Perhaps the best way to show how intimately Shakespeare knew the facts will be to examine his so-called errors and especially one that has attracted some attention in the past, and apparently taxed the resources of commentators to explain. In several plays Shakespeare ascribes a certain habit to the cuckoo. These quotations are given below in their chronological order.

> Why should the worm intrude the maiden bud?
> Or hateful cuckoos hatch in sparrows' nests?
>
> —"Lucrece," l. 848–9.

> And being fed by us you us'd us so
> As that ungentle gull, the cuckoo's bird,
> Useth the sparrow; did oppress our nest;
> Grew by our feeding to so great a bulk. . . .
> —"Henry IV.," Pt. 1, A. V., s. 1, l. 58 et seq.

> But since the cuckoo builds not for himself.
> —"Ant. and Cleo.," Act. II., s. 6, l. 28.

> For you know, nuncle
> The hedge-sparrow fed the cuckoo so long,
> That it had it head bit off by it young.
> —"Lear," Act I., s. 4, l. 237 et seq.

An investigation of these passages proved extremely diverting because of the varied ways in which the different critics and Shakespearian editors tried to explain, dodge or ignore the question—Was Shakespeare at fault in accrediting such habits to the cuckoo?

In the lines from "Lear," moreover, two disputed textual passages occur. The Globe edition has the last line:

> That it had it head bit off by it young

which is awkward and meaningless. This line some other editions boldly change to just the opposite and have two "its," reading:

> That it had its head bit off by its young.

Furness in the Variorum edition inclines to the reading

> That it's had it head bit off by it young

explaining his "it's" as a contraction for it has, which would seem to give sense to the passage, *i. e.,* that it (the sparrow) has had it (the sparrow's) head bit off by it (the cuckoo) when still young.

Again in the case of the phrase "For you *know* nuncle" the Globe reading and the Variorum edition agree on the above; (nor is there anything said about a different reading in the Variorum). Yet Schmidt in his Shakespeare Lexicon defines "*trow* = believe" for this passage; and so it is printed in Knight's edition of Shakespeare's works. Now let us see what the commentators have to say regarding the natural history of the lines.

Mr. J. E. Harting, the ornithologist, after quoting all three passages, dodges the issue:

> The solution of this question is the more puzzling from the fact that this parasitical habit is not common to all species of the genus cuckoo. An American species builds a nest for itself and hatches its own eggs. The habits of our English bird must always be as much a marvel to us as its remarkable voice, etc.

Mr. Chas. Knight, the Shakespearian editor, pins his faith to "trow,"

adopting this reading without question and triumphantly champions the poet as follows:

> There is a remarkable instance in his (Shakespeare's) discrimination between the popular belief and the scientific truth in his notice of the habits of the cuckoo. The Fool in "Lear" expresses the popular belief in a proverbial sentence:
>
> For you trow nuncle
> The hedge sparrow fed the cuckoo so long
> That its had its head bit off by it young.
>
> Worcester, in his address to "Henry IV.," expresses the scientific fact without the vulgar exaggeration, . . . a fact unnoticed until the time of Dr. Jenner by any writer but the naturalist William Shakespeare:
>
> And being fed by us you us'd us so
> As that ungentle gull, the cuckoo's bird,
> Useth the sparrow; did oppress our nest,
> Grew by our feeding to so great a bulk. . . .

Mr. J. E. Harting, some half dozen pages after his first dismissal of the subject, recurs to it again:

> The opinion that the cuckoo made no nest of its own but laid its eggs in that of another bird, which brought up the young cuckoo to the detriment of its own offspring, was well known to the ancients and is mentioned by Aristotle and Pliny.

The more recent scientific discussions of this bit of natural history are interesting reading, in view of the decided differences of opinion among the commentators. The Victoria History of Warwickshire, because of the thorough manner in which the various subjects are treated, is a valuable reference book on Shakespeare's native county. The section on the Ornithology of Warwickshire was written by Mr. R. T. Tomes, F.G.S. and corresponding mem. Z. S., who under the head of "the cuckoo" (although he makes no reference to Shakespeare) has the following sentence:

> I have long been of the opinion that the female cuckoo lays her eggs on the bare ground, from which she takes them in her beak and places them in the nests of other birds.

He cites instances when he has observed this transference of the egg.

Other British ornithologists, in general, believe that the cuckoo not only deposits its egg in some smaller bird's nest, but also that the cuckoo fledgeling, by an upward jerk of its rump, hurls the true offspring of its foster parents from the nest; and itself grows so large before leaving this that the foster parents are compelled to perch on the fledgeling's shoulders, in order to convey food to its gluttonous maw. Under the circumstances is it not a plausible enough theory, that Shakespeare did witness some such tragedy as is indicated in the Fool's lines;

and that he therefore needs no learned etymological or ornithological defense?

The other so-called natural history errors of Shakespeare are probably enough, as Mr. Knight contends, due to his reliance on books; as Knight puts it:

> Shakespeare derived his nature truths from observation, his untruths from books.

Such errors are:

> The toad, ugly and venomous,
> Wears yet a precious jewel in his head.
> —"As Y. L. It," A. II., s. 1, l. 13–4.

> Now I will believe . . .
> That . . . in Arabia
> There . . . is one phoenix.
> —"Tempest," A. III., s. 3, l. 22 et seq.

Knight, curiously enough, in view of his elucidation of the cuckoo episode, fails to note in this connection the rather obvious fact, that such errors are given as beliefs of the characters who express them, or, indeed, as expressions of their own skepticism, as in the case of the phoenix, and are, not therefore, to be construed as accepted by Shakespeare himself.

The limitations of this paper preclude considering in detail all the divisions of natural history that Shakespeare knew at first hand. It must suffice that we pick out several of the more noteworthy for examination. As in the case of the birds, Shakespeare's insects attract attention because of the remarkable number of species mentioned.

When we think of the very small number of insects that the average person, to-day, can call by name, how many less he knows, or remembers the habits of, and that even now only a very small proportion of the classified species have popular names; we can better appreciate the range and quality of that man's observations, who in the city, far from their haunts, wrote about, from memory, almost all the species possessing popular names, that were native to his youthful home. Mr. Robert Patterson, an entomologist (Treasurer of the Natural History Society of Belfast), found that the passages in Shakespeare containing notices of insects occupied "nine closely written pages of letter paper." He has not printed this list, but we may surmise from his language that he considered it extensive, in fact he says elsewhere that he was "surprised at the amount of natural history contained in the plays."

It needs only a short search to come upon a passage revealing more than a merely superficial knowledge of this topic. If a modern entomologist were made a dramatist, he could not better voice scientific fact than Shakespeare has in the lines:

There is differency between a grub and a butterfly; yet your butterfly was a grub.

—"Coriolanus," A. V., s. 4, l. 12–13.

It can not be too often reiterated that nature knowledge, such as displayed in this sentence, was nothing less than extraordinary in a sixteenth-century poet. Because the phases of the butterfly's life history are commonly known to-day, we are apt to pass over the expression without thinking of its real import—that at a time when natural history abounded in absurdities and superstitious beliefs, this man stated the facts. Again his uses of these facts and keen observations are at times imaginative to a fascinating degree. When Mamillius in "The Winter's Tale" whispers:

I will tell it softly;
Yond crickets shall not hear it.

—Act II., s. 1, l. 29–30.

his conception of the crickets as listeners, because they cease their clamorous chirpings, remaining absolutely silent as long as you converse in their vicinity, is a very pleasing fancy.

When the sun shines let foolish gnats make sport,
But creep in crannies when he hides his beams.

—"Com. of Errors," Act II., s. 2, l. 30–31.

And often, to our comfort, shall we find
The sharded beetle in a safer hold
Than is the full wing'd eagle.

—"Cymbeline," Act III., s. 3, l. 19 et seq.

are on the other hand passages embodying bits of philosophy which might well have found place in Bacon's essays.

There are, in other of these insect passages, unrivalled quaintness and suggestiveness. No other poet has surpassed in imagery the conceits Shakespeare has made familiar in the description of Queen Mab's chariot and its fittings.

Her chariot is an empty hazelnut
Made by the joiner squirrel or old grub,
Time out o'mind the fairies' coach-makers.
(Its) . . . wagon-spokes made of long spinner's legs
The cover, of the wings of grasshoppers
The traces, of the smallest spider's web.
Her whip, of cricket's bone; the lash of film;
Her waggoner, a small grey-coated gnat.

—"R. and J.," A. I., s. 4, l. 60, etc.

Here must be inserted too that queer stanza:

The fox, the ape and the humble-bee
Were still at odds, being but three,

Until the goose came out of door
And stay'd the odds by adding four.
—"L. L. L.," A. III., s. 1, l. 90 et seq.

This is sheer nonsense and would adorn Lewis Carroll's "Alice's Adventures in Wonderland."

Passing from animate to inanimate nature, we think first of flowers, the beautiful things of creation. Perdita's speech in "The Winter's Tale," so often quoted, claims first attention:

O Proserpina!
For the flowers now that frighted thou let'st fall
From Dis's waggon! daffodils,
That come before the swallow dares, and take
The winds of March with beauty; violets dim,
But sweeter than the lids of Juno's eyes
Or Cytherea's breath; pale primroses,
That die unmarried, ere they can behold
Bright Phoebus in his strength, a malady
Most incident to maids; bold oxlips and
The crown imperial; lilies of all kinds
The flower-de-luce being one.
—Act IV., s. 3, l. 116 et seq.

As has so often been pointed out, she keeps precisely to the order of the season, while Milton, in a like passage, flagrantly violates the calendar of nature.

Mr. Hamilton Wright Mabie has made the interesting discovery, that there is only one place near Stratford:

Whereon the wild thyme blows.
—"M. N. D.," A. II., s. 1, l. 249.

and that it is a bank along the path to Shottery. If we may judge by the context of this passage, the associations coupled in Shakespeare's mind with this path, and bank, were not nearly so unpleasant as some commentators would have us believe.

The subtleties of trees' growth and habits, their characteristics and individualities, have not been lost on Shakespeare. He notes the reflection where

There is a willow grows aslant a brook
That shows his hoar leaves in the glassy stream.
—"Hamlet," Act IV., s. 7, l. 167–8.

Only the under side of the willow's leaves are hoar; again Shakespeare's statement is perfectly exact. In the "Rape of Lucrece" we have

The cedar stoops not to the base shrub's foot
But low shrubs wither at the cedar's root.
—"Lucrece," l. 664–5.

which observation must always please the geographical botanist.

Shakespeare, while so widely conversant with the minutiae of nature, was not blind or indifferent to her broader aspects. For these, also, he had an appreciative eye. He noted the pageants of the clouds; the manifold shapes they assume:

> Sometimes we see a cloud that's dragonish;
> A vapour sometimes like a bear or lion,
> A tower'd citadel, a pendant rock
> A forked mountain, or blue promontory
> With trees upon't, that nod unto the world
> And mock our eyes with air.
>
> —"Ant. and Cleo.," Act IV., s. 12, l. 3 et seq.

The colorful picture he presents in the lines

> When daisies pied and violets blue
> And lady-smocks all silver-white
> And cuckoo buds of yellow hue
> Do paint the meadows with delight.
>
> —"L. L. L.," Act V., s. 2, l. 902 et seq.

is surely a laughing, happy one of spring; while again, what could be more realistic than the autumn he depicts in Sonnet 73:

> That time of year . . . behold
> When yellow leaves, or none, or few, do hang
> Upon those boughs which shake against the cold
> Bare ruin'd choirs, where late the sweet birds sang.

These very many nature notes, sprinkled almost uniformly throughout his work, show how intimately the nature lover was associated with the poet in Shakespeare's art. Their quality indicates the patient seeking for the inner reason of things, that is the characteristic of the man of science. Individually the passages please us as does a tinkling chime of silver bells. The striking applications that the dramatist makes of these lines show him, however, a master of his art. Critics assert that certain of these nature passages were independent compositions that were later fitted into the plays and poems where they occur (by their author) in order that they might not be lost. The story of the hunt, in Lucrece, is commonly mentioned as an example of such interpolation. Granted that this be true, has any one ever ventured to say that these passages serve no purpose, or that they are inapt? Quite the contrary! It is remarkable enough that, although critics disagree about almost all else, on this one point they stand united: Shakespeare's similes and metaphors are always appropriate and clear. The German Shakespeare scholar, Dr. C. C. Hense, has even found himself called upon to defend Shakespeare's unrestrained and literal use of nature truths with such correctness.

If fault can really be found with the poet's usage; Hense's defense of it is bold and convincing. He says:

Man hat wohl von Shakespeare gesagt, das er die Schönheit der Warheit und Wirklichkeit unterordne. In seiner Verwendung der Naturverhältnisse tritt eine Wahrheit hervor, für welche der delikatere Sinn der späteren Zeit die Emphänglichkeit zum Teil verlor. Die Dichter des Altertums, der Natur näher stehend, vergleichen mit unbefangener Naturfrische Menschen mit Tieren; der tadelnde Beigeschmack, welchen der Vergleich mit gewissen Tieren einschlieszt, war in dem unbefangenen Natursinn der Alten nicht vorherrschend.[1]

He then cites passages from Homer, Horace, and other classical authors illustrating the decidedly "unconventional" comparisons they commonly employed. Nor was this appropriateness of Shakespeare's nature references confined to the minutiae of his work. To quote another German author, H. Heine, every drama has

Sein besonderes Clima, seine bestimmte Jahreszeit, und seine lokalen Eigentümlichkeiten. Wie die Personen in jedem dieser Dramen, so hat auch der Boden und der Himmel, der darin sichtbar wird, eine besondere Physiognomie.[2]

Thus we have the action of Romeo and Juliet taking place in sunny Verona, while Hamlet and Macbeth live their tragic lives under the gloom and fog of northern skies.

Turn now from the poet's written interpretation of his feeling and observations to a contemplation of the man himself, as revealed by those lines. Shakespeare, the nature lover—this phrase in itself expresses one of the most delightful conceptions we have in the history of literature. The conception is all the more pleasing if we accept the conclusions drawn by Mr. C. Creighton in his curious book entitled "Shakespeare's Story of His Life," wherein he attempts to unravel the biography from allusions in the poet's work. According to it Shakespeare's life in large part must have been very unhappy, for it is a tale of naught but quarrels, disappointed ambition and heartburnings arising from misplaced friendships. In any case, although he did not avoid society as did Thoreau, Shakespeare's joy in a secluded footpath must have been great, particularly if he was so unhappy in his social life.

Imagine how his heart must have surged and expanded away from public haunt, finding

Tongues in trees, books in the running brooks
Sermons in stones, and good in everything.
—"As Y. L. It," Act II., s. 1, l. 16–17.

[1] It is true that Shakespeare has been accused of subordinating beauty to truth and realism. This is only so because in his nature references a verity is apparent that a later generation has in part lost its ability to appreciate owing to the development of a greater fastidiousness. The classical poets, in closer touch with nature, compared man with the beasts in a very unconstrained and naïve fashion. Because of their unconventional attitude toward nature these early writers were not dominated by a number of modern taboos, including that of comparisons with certain animals.

[2] Its suited climate, appropriate season, and local peculiarities. As the characters in every one of these plays, so also the earth and sky depicted therein, have each their distinctive and characteristic aspects.

"Good in everything." What an amount of satisfaction may be expressed by the word good. We feel its real force, now, better, when we hear "goodly": "a goodly sight it was. . . ."

One thing which must always make us happy is that we may feel reasonably sure that the poet spent the last few years of his life at his boyhood home, and that he could in those years satisfy the longing so feelingly expressed in the lines:

> O God! methinks it were a happy life,
> To be no better than a homely swain;
> To sit upon a hill, as I do now,
> To carve out dials quaintly, point by point,
> . . . .
> Ah! what a life were this! how sweet! how lovely!
> Would bring white hairs unto a quiet grave.
>
> —"Henry VI.," Pt. 3, Act II., s. 5, l. 21 etc.

SHAKESPEARE AS HEALTH TEACHER

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ACCORDING to the notions of the age in which he lived, Shakespeare would hardly have been recognized as a "doctor of physic," but from the twentieth century point of view he was, and is, a great physician. A curer of disease he certainly was not, but as teacher of mental and bodily sanity he has had a clientele that is numberless.

So superior a mind must have had an aversion to the company of the average doctor of medicine of the time. Their "science," which he evidently sifted to the bottom, was largely nonsense, and their practise consisted chiefly in the indiscriminate letting of blood and the administration of sundry traditionary, and not always safe, concoctions. Had he joined their ranks, however, and become a "curer of the body," Shakespeare would have allowed little to escape his keen senses in his study of the sick, and his weighing of signs and symptoms would have been made with nice judgment. Above all, he would have "understood" his patient—he would have had a rare insight into the condition of mind underlying or resulting from the bodily derangement and felt the importance of ministering unto "the immortal" as well as unto the corporeal part of his nature. At least he would have been honest and would have admitted as much, if the sick man needed more "the divine than the physician."

Medical science in and about the year sixteen hundred was so limited and so steeped in astrology and metaphysics that its professional study could hardly have appealed to many, save those who delighted in one or the other of these vagaries. Indeed, metaphysics and astrology were necessary to fill up the great hiatus of ignorance of the body itself in health and disease. Neither of these speculative pursuits offered a very firm basis on which to establish the art of healing. Though much progress had been made in gross anatomy, the compound microscope had yet to be invented and the science of physiology was, as yet, practically a blank book. The processes of digestion were vaguely understood, but there was complete ignorance of respiration and of circulation, and the brain was only coming to be recognized as the seat of consciousness. There was as yet but a hazy guess at the nature of infectious disease.

Practitioners of physic still leaned heavily, for support of their otherwise usually supportless practises, upon the ancients. "Thus saith Galen" or "so rules Hippocrates" was prefixed to most medical for-

mulæ. The ascendancy of Galen was especially complete in England. True, the name of Avicenna was not unknown, and the learning of the Arabians was not wholly neglected. A lively leaven of independence of authority had also been set working in the middle of the sixteenth century by the audacious Paracelsus (mentioned by Shakespeare in "All's Well that Ends Well") who dared to proclaim that his shoe buckle knew as much as all the ancients, and, what was more modest and vastly more important, declared that he, as well as they, could study nature first hand. It is evident that some of the English men of medicine were equally free from the trammels of tradition, for William Harvey was but fourteen years younger than Shakespeare. But, among all but a few, Galen was the medical god; the normal condition or "temperament" of the body was believed to depend upon the right mixture of the four elusive elements of the Greek thinkers—hot, cold, moist and dry—while from faulty proportioning of these there arose "distempers," and from distempers, under certain external conditions of food, of air, or more subtle phenomena, there developed disease.

Ailments—their cause and cure—were then, as now, matters of common conversation. Each man diagnosed his neighbor's complaint and suggested his own favorite remedy. There were even popular health books—and not bad ones. The "Castell of Helth," probably the first of these, was compiled (chiefly from Galen) in 1554 by no less a person than Thos. Elyot, Knight, privy councillor to Wolsey, intimate of Cromwell, etc. Its publication aroused the ire of the profession because of the sacrilege of the translation into the vernacular, because the translator was a layman, and for less worthy reasons. Fifty years later, when Shakespeare's earlier plays were leaving the press, Thomas Cogan, a humble physician and teacher, published the "Haven of Health, made for the comfort of Students." Shakespeare may have glanced through this work, which displayed some little wit and good sense, but for the material of which the author acknowledged himself much indebted to Master Elyot, "his Castell of Helth."

Then, as now, however, it was not so much the invention of cures for its ailments that was most needed for humanity, but an insight into the cause, and, therefore, into the prevention of disease. In London and in the village of Stratford (were rural conditions worse than urban then, as they usually are now?) men lived in the most filthy fashion, and they unwittingly reaped the consequences of their uncleanliness. Even John Shakespeare, father of the dramatist, well-to-do chief magistrate though he became, was fined for having a dunghill in his front yard. The condition of the rest of his premises is not pleasant to contemplate, and yet it is said that his illustrious son, in his first year, escaped the plague which carried off one sixth of the population of Stratford, only because his home was the most comfortable and sanitary in

the place. To the older scourges of unsanitary Europe, there had been recently added by the voyagers to new worlds some new plagues. Notable among these acquisitions was syphilis, which wrought havoc among all classes, and which, despite its own tendency to self-destruction and the brilliant work of modern medicine, still reaps a plenteous and hideous harvest of death and deterioration.

Whether Shakespeare's home surroundings saved him as an infant from his first experience with the plague, it allowed him opportunity for the fullest unfolding of his bodily powers, and gave him the appreciation of the feeling of health. He lived in a village of less than fifteen hundred inhabitants; there was a river in which to fish and swim, and there were inviting fields over which to rove and hunt with horse and hawk and hound. He could draw a "good long bow" and was well practiced in self-defense with quarterstaff and sword. That he made use of his opportunities for physical education is evidenced by the lines of autobiography scattered through his plays.

His stay in the public school was brief, and his health was unaffected by study. Cogan found that students then "be commonly valetudinary, that is sickly." Shakespeare did not belong to this class. His was a "lusty" youth, which led, by suitable living (despite some probable excesses and escapades), to a lusty age, for it is not believable that one who looked with so rare and philosophic vision at the strutters upon life's stage, could himself have been guilty of much of their weakness. Besides, the very great man is seldom given to dissipation. There is too much else for him in life.

In Shakespeare's earlier plays there is (saving the introduction of Pinch the "hungry, lean-faced villain" and quack into "The Comedy of Errors") little mention of physic and less of physicians, and he seems to have, in or out of his plays, no use for the services of a doctor of physic. He was approaching the age of sedentariness, however, had already learned that "unquiet meals make ill digestion," and perhaps other experiences of minor bodily ills followed and aroused his especial interest in such matters. At any rate, after 1597 the words "physic" and "physical," used often in the general sense of something salutary, appear frequently.

In "Henry the Fourth" (1597–1598) Shakespeare exhibits considerable knowledge of medical matters, Falstaff furnishing the material of his public clinic. He pictures accurately the bodily changes of senility; he mentions apoplexy, the gout, the pox (syphilis), and epilepsy; and in speaking of grief as leading to apoplexy he makes Falstaff say, "I have read the cause of its effects in Galen." The remark of Prince Henry

. . . . If he be sick
With joy, he will recover without physic,

shows his observation of the effects of mental states on bodily, and vice versa.

Shakespeare's interest in "physic" and his intimacy with physicians may have been simultaneous; perhaps the latter preceded the former. His opinion of the average doctor of the day is presented in probably a not much exaggerated way in his Doctor Caius, in "The Merry Wives of Windsor" about the year 1600. This and the plays of the next four years are full of fun and sarcasm at the expense of the profession, with little hint that there might be in it any but charlatans and ignoramuses.

> Will you cast away your child on a fool and a physician?
>
> He hath abandoned his physicians, madam; under whose practices he hath persecuted time with hope.
>
> Throw physic to the dogs. I'll none of it.
>
> *Sir Toby.*
>
> Sot, did'st see Dick Surgeon, sot?
>
> *Clown.*
>
> O, he's drunk, Sir Toby, an hour agone; his eyn were set at eight i' the morning.

These were not expressions wholly respectful to the learned practitioners of medicine and surgery.

In "Troilus and Cressida" he again shows much familiarity with the bodily ailments of the age. By the time he wrote "Lear" and "Macbeth" (1605) he had evidently come upon more worthy material in the medical profession. The doctors of these plays are large-minded, sympathetic, and unhampered by tradition, above all exhibiting keen appreciation of the phenomena of mental aberration and a readiness to admit the fact that

> . . . this disease is beyond my practice.

It was not the habit of the majority of the doctors of physic to admit that they could not cure insanity, or anything else, by some material means. Shakespeare recommends for such patients rest, sleep, and a removal of "the means of all annoyance"; his decision concerning Lady Macbeth,

> More needs she the divine than the physician,

foreshadows, by three centuries, the general popular and professional agitation concerning the value of mental treatment of nervous disorders.

Shakespeare had full opportunity at hand for the study of insanity in many of its forms—the great majority of those afflicted were abroad in the land, though the more violent were chained in loathsome prisons or confined in little better "asylums." Far down into the seventeenth century the cause of insanity was laid at the door of demonology and witchcraft, and it is to be remembered that hospitals for the insane and

their humane treatment date back little more than a half century. Like a true scientist, Shakespeare shows chief interest in the border-line cases; and, to this day, the critics, after close examination of his most famous study, "Hamlet," have been unable to say whether the subject was or was not insane. The dramatist would probably have said that he was both. Shakespeare must have had a deep fellow feeling for the insane, especially for those so near to mental health. There must have been, beneath his careful delineations, more than mere art for art's sake, and there was painstaking truthfulness not in exhibiting some spectacular cures but in lauding the effects of the commonplace influences of

> Our foster-nurse of nature

and of

> Sleep that knits up the ravelled sleeve of care.

Not only did he warn against the conditions which push men across that narrow and invisible line which forms the boundary between sanity and insanity of the mind, but, as Mr. Rolfe said, Shakespeare "went out of his way" as a playwright to preach, even to the warning against the danger from a common cold, the gospel of bodily health.

In *Coriolanus* (1606) he gives a considerable number of lines to the subject of the interdependence and need of harmony among the organs of the body. The other structures rebelled against the stomach and

> . . . . accused it:
> That only like a gulf it did remain
> I' the midst o' the body, idle and unactive,
> Still cupboarding the viand, never bearing
> Like labor with the rest.
> . . . .
> "True it is," quoth the belly,
> "That I receive the general food at first,
> Which you do live upon; and fit it is,
> Because I am the storehouse and the shop
> Of the whole body: but if you do remember,
> I send it through the rivers of your blood,
> Even to the court, the heart—to the seat o' the brain;
> And, through the cranks and offices of man,
> The strongest nerves and small inferior veins
> From me receive that natural competency
> Whereby they live."

We are strongly reminded of Shakespeare's greatest contemporary, Cervantes, who makes his hero say to Sancho "The health of the whole body is tempered in the laboratory of the stomach." Was Shakespeare familiar, at the time, with Don Quixote?

The dramatist more than once called attention to the result of taking too much food into the stomach, for

> Fat stomachs have lean pates, and dainty bits
> Make rich the ribs, but bankrupt quite the wits.

Falstaff is, in himself, an eloquent sermon on temperance.

Drunkenness received no gentle rebuke from Shakespeare's pen.

> What's a drunken man like, fool?

asks Olivia of Feste in "Twelfth Night" (1601).

> Like a drowned man, a fool and a madman. One draught above heat makes him a fool; the second mads him; and a third drowns him.

and in "Othello," Cassio bewails at length the folly of his intemperance.

> Oh God, that men should put an enemy in their mouths to steal away their brains! that we should, with joy, pleasance, revel and applause, transform ourselves into beasts! . . . To be now a sensible man, by and by a fool, and presently a beast! O strange! Every inordinate cup is unblest, and the ingredient is a devil.

Shakespeare paints the picture of the victim of venereal disease with no sparing of pigment and with no uncertain sweep of the brush. He even goes to the pains (not for the sake of creating a sensation) of exhibiting the foulness and baseness of the "sty" where

> Diseases have been sold dearer than physic.

It is in this same play, "Pericles"—nearly his last—that Shakespeare describes his ideal physician, or some real doctor of physic whom he admires. Possibly he had in mind his son-in-law John Hall; but Shakespeare himself was most worthy of the lines:

> . . . . 'Tis known, I ever
> Have studied physic. Through which secret art,
> By turning o'er authorities, I have
> (Together with my practice) made familiar
> To me and to my aid, the blessed infusions
> That dwell in vegetatives, in metals, stones;
> And I can speak of the disturbances
> That Nature works, and of her cures; which doth give me
> A more content in course of true delight
> Than to be thirsty after tottering honour,
> Or tie my treasure up in silken bags
> To please the fool and death.

Shakespeare was not a student of sanitation, for the sources of infection, other than in a most hazy way, were as yet unknown. Had he lived to-day he might have pointed a telling finger at our public and private uncleanliness. It is probable that he was the victim of filthy

conditions at Stratford, for he died of a fever of not long duration. Doubtless he was, in this illness, ministered to by his son-in-law who had gained an enviable reputation as a physician and was much sought after by "those of more than ordinary understanding" and even by "such as hated him for his religion."

Though he died at fifty-two, Shakespeare had, according to the reckoning of Montaigne, a quarter century earlier reached, for that time, a good old age. Probably had it not been for some unavoidable cause, his superior physique, his appreciation of health, and his temperance would have preserved him many years more. He had, however, completed his work, for he had ceased to write, so far as we know, two years before his end.

He would not have considered himself a physician, but in the most important sense of being a teacher of health he stands among the first of that goodly company of non-professionals: Plato, Cervantes, Molière, Montaigne, Bacon, Locke, Addison, Wesley, Franklin, Carlyle, Beecher, Spencer, and others who, by both precept and practise, have been our greatest preachers of the gospel of health. As a minister to the mind, and, through it, to the fragile machinery through which it works, he has no peer.

AN ANALYTICAL STUDY OF ATHLETIC RECORDS

By GEORGE P. MEADE

CARDENAS, CUBA

IN June, 1915, Norman Taber, formerly of Brown University and Oxford, ran a mile in 4 minutes 2⅗ seconds, about two seconds faster than any amateur had ever been credited with running that distance. The question may have occurred to some of us at that time, "How far can the breaking of records continue?" Improvement in technique or in method may affect such records as the high jump and the pole vault; changes in apparatus may affect others such as the hammer-throw, but running is an act so natural and free from "knack" that it would seem probable that there is some rule governing the rate at which man can run—some limit which the records approach and beyond which they are not likely to go. Before looking into the matter further let us consider the class of figures with which we have to deal.

Athletic records have every right to consideration as scientific data. Races are timed by at least three skilled timers; distances are accurately surveyed and are remeasured in case a claim for a record is to be made; strict rules are observed to prevent mistake or fraud at the start and finish, and unusual circumstances, such as favoring winds, are noted by judges or referee. Finally the performance is investigated by a committee of the national athletic board of the country in which the race was run, and every circumstance which might affect the validity of the record is discussed before the record is sanctioned. (These precautions apply only to amateur athletics. Professional races are run under haphazard conditions, and timing is unreliable, so professional records will not be dealt with here at all.)

Athletic events may be divided into two classes—those which are run in all championship meets, and for which athletes practise regularly, and those which are run more rarely and for which practise is incidental. Of the first class, which we might term "standard" events, are the 100-yd., 220-yd. and 440-yd. dashes, the half-mile, mile, two-mile and five-mile runs. It is in these standard events that world-wide competition has been going on for many years. So many thousands of men have striven to break these records that they may be taken as closely approximating the best which *man* can do, rather than as representing the best which men have been able to do so far.

In order to compare the speeds at various distances it is necessary to compute the rate for some unit distance. For distances below five miles the seconds per 100 yds. is used as the unit. (For example, the record for the half mile is 1 min. 52½ secs., or 112.5 secs. The rate per 100 yds. is $\frac{112.5}{8.8}$ or 12.79 seconds.) For distances greater than five miles the rate is computed to seconds per mile.

Let us consider the world's best running records for the standard distances as given in Spalding's Athletic Almanac for 1915. The last column gives the rate per hundred yards, computed as shown above.

Distance	Time	Holder	Rate per 100 Yds.
100 yds.	$9\frac{3}{5}$ secs.	Kelly	9.60 secs.
220 yds.	$21\frac{1}{5}$ "	Wefers	9.59 "
440 yds.	$47\frac{4}{5}$ "	Long	10.86 "
880 yds.	$1{:}52\frac{1}{2}$ "	Meredith	12.79 "
One mile	$4{:}12\frac{3}{5}$ "	Taber	14.35 "
Two miles	$9{:}09\frac{3}{5}$ "	Shrubb	15.60 "
Three miles	$14{:}17\frac{3}{5}$ "	Shrubb	16.22 "
Four miles	$19{:}23\frac{2}{5}$ "	Shrubb	16.52 "
Five miles	$24{:}33\frac{2}{5}$ "	Shrubb	16.73 "

A study of these rates shows that for the 100-yd. dash and the 220-yd. dash the rate is practically identical. Here the fatigue in running the longer distance is offset by the greater effect of the delay at the start on the rate of the shorter dash. Beginning with the 220-yd. dash rate,

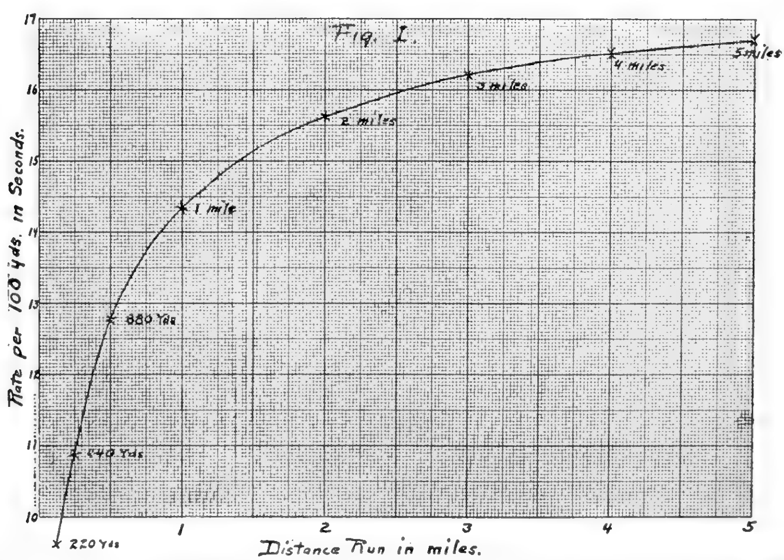

Fig. 1. Curve Representing the Relationship, for the Standard Distances, between the Rate of Speed and the Distance Covered.

however, we note that the rates increase for each succeeding distance, but with a constantly decreasing increment.

Representing the rates as vertical distances and the miles as horizontal distances, we can show graphically the relationship between the rates, as in Fig. 1.

The smoothness of the curve connecting all the points plotted is striking—so striking, indeed, as to indicate strongly that there is an approach to a definite relationship between the various records which have been reduced by extended competition. No claim is made that the limit has been reached in the breaking of these records. Such a claim might be refuted by actual performance in the next athletic meet. But the probability of any marked change in the records represented by the curve is very remote.

To show the effect of competition on the rates, let us plot some of the second class of events (that is, those which are run more rarely). As instances we will choose the following:

Distance	Time	Holder	Rate per 100 Yds.
1,000 yards................	2:12$\frac{2}{5}$	Sheppard	13.40
$\frac{3}{4}$ mile........................	3:02$\frac{1}{5}$	Conneff	13.84
$1\frac{1}{2}$ miles.....................	6:46$\frac{2}{5}$	Conneff	15.39

These points are plotted in Fig. 2, together with the curve already shown in Fig. 1. The points, as might have been expected, fall outside

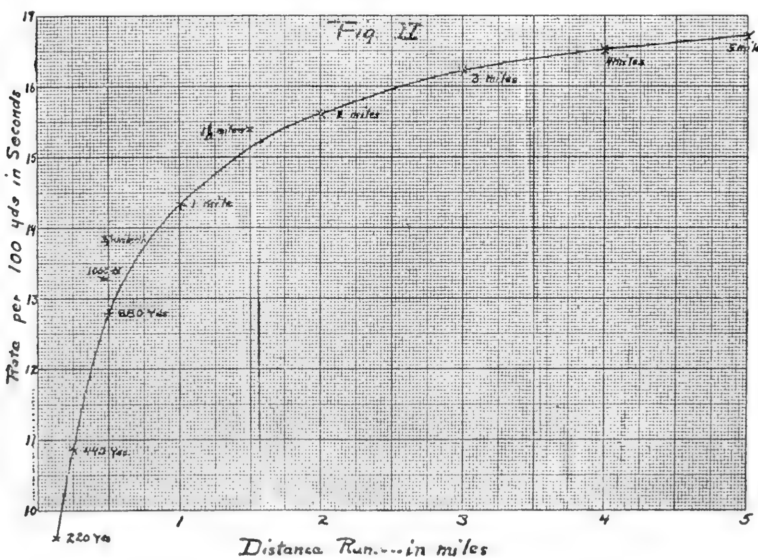

Fig. 2. The Same Curve as in Fig. 1, together with Points Plotted for Rate and Distance for 1,000 Yds., ¾ Mile and 1½ Miles. Showing that for distances in which competition has been less keen the points fall outside the curve.

the curve. The rate for these less usual events is, therefore, greater than in the standard events. There is little doubt that if these distances were included in the regular schedule of championship events the records would fall until the points were included in our curve.

For convenience in studying the records for distances beyond five miles the rates are calculated to seconds per mile, instead of seconds per 100 yards. Following are the records and calculated rates:

Distance	Time	Holder	Rate per mile
440 yds.	$47\frac{4}{5}$ secs.	Long	191.2 secs.
$\frac{1}{2}$ mile	$1{:}52\frac{1}{2}$ "	Meredith	225.0 "
One mile	$4{:}12\frac{3}{5}$ "	Taber	252.6 "
Two miles	$9{:}09\frac{3}{5}$ "	Shrubb	274.8 "
Three miles	$14{:}17\frac{3}{5}$ "	Shrubb	285.8 "
Four miles	$19{:}23\frac{2}{5}$ "	Shrubb	290.8 "
Five miles	$24{:}33\frac{2}{5}$ "	Shrubb	294.7 "
Ten miles	$50{:}40\frac{3}{5}$ "	Shrubb	304.0 "
11.82 miles	One Hour	Bouin	304.4 "
Fifteen miles	$1{:}20{:}04\frac{3}{5}$ "	Appleby	320.3 "
Twenty miles	1:51:54 "	Grossland	335.7 "
Twenty-five miles	$2{:}29{:}29\frac{2}{5}$ "	Green	358.7 "

These rates and distances are shown in Fig. 3. The one-hour record seems to be a continuation of the smooth curve obtained for the shorter

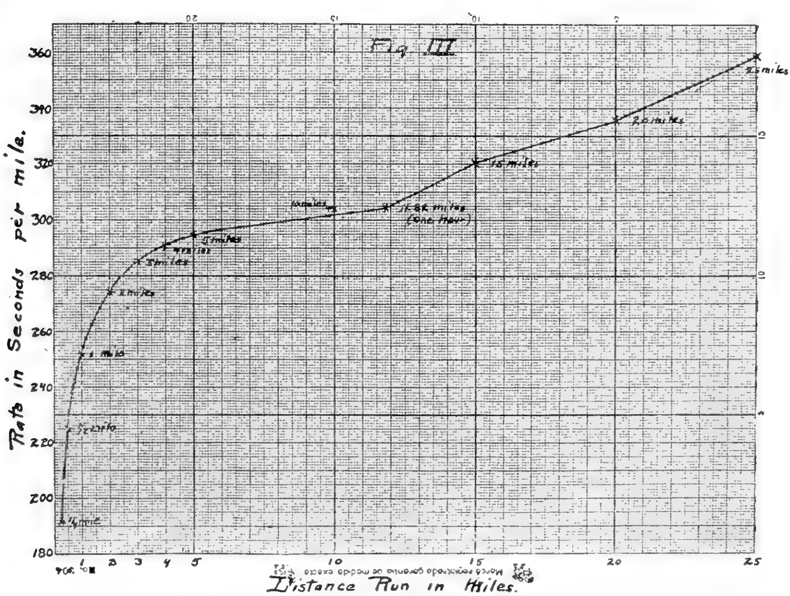

FIG. 3. THE RELATIONSHIP BETWEEN RATE OF SPEED AND DISTANCE RUN CONTINUED FOR RECORDS UP TO 25 MILES. (The rate here is in seconds per mile, instead of seconds per 100 yds., as in Figs. 1 and 2.)

distances, with the ten-mile record slightly out of line. It is of interest to note that this ten-mile record was made by Shrubb while he was

making the one-hour record formerly held by him. It is evident that if either Shrubb or Bouin had been running only ten miles, instead of for one hour on the day their records were made, the ten-mile record would be better and the point would fall within the curve.

Beyond the one-hour mark the curve breaks badly. Correct figures on professional races for the greater distances might tell a different story. In these longer races a money incentive might do more toward bringing out the full extent of man's abilities. Or it may be that whatever rule governs the records in the shorter distances does not apply in the longer ones. This does not seem as probable, however, as that the full possibilities have not been realized.

We have seen, then, that for those distances up to ten miles in which competition has been most intense there is apparently a rule governing the relationship between the distance covered and the rate. It may be that some mathematician who still has an interest in the sporting page will develop the formula on which this relationship is based.

THE ACCELERATION OF MORAL PROGRESS

By Dr. DURANT DRAKE
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WE Americans, and those among the warring nations of Europe who have leisure for reflection, stand aghast at the revelations of human hatred, cruelty, and barbarism which this past year of our Lord has thrust under our eyes. Where is all our boasted moral progress, our Christianity, our dream of the brotherhood of man? What was it all but a thin veneer over the black depths of brute selfishness and savagery? No wonder if many despair of the capacity of man to progress morally, and others look impatiently about for some new force to do for him what all the churches and societies have hitherto failed to do. It was, therefore, a timely as well as an interesting article which appeared in a recent number of *The Popular Science Monthly*[1] with the contention that the hope for moral progress lies along the line of eugenics.

Hitherto, the thesis of this paper ran, morality has been almost wholly a matter of social inheritance, a set of traditions imposed from without upon each succeeding generation, adopted by imitation and suggestion, perpetuated largely through fear of the penalties or social ostracism which follow upon deviation, but always more or less external to human nature itself, crossing its desires, demanding repression and conformity. Such a situation is pregnant with danger. Red-blooded youth will always be rebelling against its constraints; and any great wave of passion, like this present war, will fling its shackles to the four winds. Evidently there can be no secure morality until men are born with altered natures, with impulses and desires organically adjusted to the needs of their human situation, so that they instinctively and spontaneously choose the right. In short, our problem is that of "securing the preservation and perpetuation of a human stock that may be depended upon to lead moral lives without the necessity of much social compulsion." "Abiding human progress can come only through the improvement of the stock of the people."[2]

Now we may all agree that such an undertaking, if feasible, is desirable, and indeed of the utmost importance. Who does not long, at least in his saner moments, to be delivered from "the body of this death," from all the harassing temptations, the lusts and longings and passions, that lead him off on this tangent or that, deflecting him from

[1] By Professor F. Stuart Chapin, in the May, 1915, number.

[2] Article referred to, pp. 469–70.

the wise and virtuous life that might otherwise be his? If we could only have been born with an overpowering inclination towards virtue, how much trouble we might have been saved! And if by regulation of marriages, by sterilization or segregation of the immoral, or any other eugenic proposal, we can secure for future generations freedom from the tyranny of passion and a life of spontaneous virtue, we should be willing to make the necessary effort and sacrifice.

But is the undertaking in any degree feasible? Let us consider it more closely. Has any one any idea how to go to work to secure "a human stock that may be depended upon to live moral lives"? Whom shall we marry to whom? That we can breed a healthier race seems undeniable; and in so far as immorality is due to low vitality, pathological derangement, organic depression of spirits, we may hope for some relief. We may perhaps succeed in breeding a more intelligent race; and in so far as immorality is due to underwittedness and stupidity we may hope to diminish it. That this is the limit of expectation seems implied in the phraseology of the paper referred to; for the author sums up his contention by saying that "we ought to get into our *mores* the idea that the children of the present generation must be born of physically healthy and mentally capable parents."[3]

Certainly we should aim to breed a healthier and more intelligent race. But will that ensure us a more moral race? We do not need this present war to enforce this lesson. Think of the Alexanders and Attilas and Napoleons throughout history; think of the Macchiavellis, the Talleyrands, the Bismarcks. Are health and mental ability in any wise a guaranty of morality? On the contrary, unless they are early and successfully enlisted in the cause of right, they are the greatest source of danger to the community. The stupid and silly may oftener do wrong; but they are not clever or strong enough to invent wrongdoing on any great scale, or to escape detection in their petty crimes. It is the criminals of great vitality and mental alertness who baffle our detectives, or, still worse, get into positions of power where they can mislead the people and further their selfish ends without incurring liability to punishment. Thus the eugenic proposals, though admirable for other ends, are not adapted to the end here sought. The task of making a man healthy and intelligent can be, to some extent, performed before he is born, by the proper selection of parents. The task of making him moral must, perforce, wait till he is born and begins to grow up.

But why can not we breed directly for morality, by preventing the parenthood of the criminal and vicious? Some men seem to have a more fortunate moral endowment than others. One child has a congenital explosiveness of temper, one youth an imperious lustfulness. Another is naturally more sympathetic, gentler, or more fearless. We

[3] *Ibid.*, p. 471.

do not start side by side in our moral pilgrimage. Then why not prevent the birth of those who would be most seriously handicapped?

The reasons why this is impracticable are numerous and obvious. In the first place, it is questionable if any instincts are in themselves bad; man's potentialities of evil are also potentialities of good. An imaginative boy sees at the "movies" the tale of a successful crime; he imitates it, is sent to jail, and becomes a hardened criminal. But that same imagination, restlessness, inventiveness and daring, if properly utilized, might have made him a great inventor, or explorer, or aeronaut. A man shows cowardice in danger. But perhaps that is the result of an extreme sensitiveness to pain, a high-strung state of nerves, which would be a very valuable endowment for an artist or an actor. Your bad-tempered friend may be one who sees more clearly than you the faults of people and cares more passionately for his ideals; train him to patience and he may be worth ten of his apathetic neighbors. The apparently selfish man may be cherishing some purpose for the sake of which he is steeling his heart against the calls upon it; his determination, concentration of energy, single-mindedness, are rare virtues, and need only to be balanced by a clearer recognition of the rights of others. The lustful man is the man of passion, who under favorable circumstances might have become a great poet or patriot. Shall we dare to weed out of our human heritage any single instinct, and say that future generations will be better off without the potentialities which it offers?

But even if we could be sure which *traits* ought to be exterminated, we should still find it impossible to determine which *individuals* ought not to become parents. For to breed for any single trait would imply disregarding all the others that would inevitably be fostered or weakened by our interference. While we were carefully breeding out selfishness we might incidentally be breeding out energy, mental keenness, invention; or breeding in, say, an over-susceptibility to alcohol or to sex incitement. He that is abounding in sympathy may be lazy, shiftless, untruthful; he that is poor in that virtue may be rich in other potentialities. We are like the children in the "Birds' Christmas Carol"; he that had a necktie had no collar, and she that had shoes had no stockings. Who is competent to judge which of the concrete blendings of impulse is on the whole deserving of extinction? The problem would be as impossible of solution as that of the God who, according to the traditional conception, has to divide human beings into sheep and goats, the saved and the damned. The fact is that one person is worth saving in one respect, another in another.

The situation is further complicated by the fact that it is impossible to be sure which qualities of a man's character are inherited, and therefore transmissible to his children, and which are acquired. An irritable, ill-

tempered individual, for example, whom we might doom to sterility for that fault, might be merely suffering from some organic irritation whose removal would leave him as patient and sweet-tempered as another; even if it were never removed, his children would have no unusual natural irritability. On the other hand, traits which are deep-rooted, and will be passed on from generation to generation, may be lying dormant, for lack of the right influences to bring them out, and go unsuspected. We inherit, after all, only potentialities; and they are but dimly to be guessed through performance. The reproductive value of a man is to be measured not in terms of what he has done, but in terms of what he might have done under widely varying circumstances; it would only be by trying him out in every type of situation and under every sort of influence that we could know what is in him. All sorts of heroisms and lusts slumber in us, unknown even to ourselves; and to judge of the value of the potentialities which any given man is going to pass on to his descendants is quite beyond our powers.

Moreover, heredity is not so simple a matter as the enthusiastic eugenist is apt to assume. A child inherits the forgotten traits of a host of ancestors, and often fails to inherit the most striking of his father's or mother's traits. There are the facts of variation, and the complexities of the Mendelian law, to be borne in mind. When two people, each with a complex ancestry, marry, who can predict what the result in inherited instinct and capacity will be? A parent with a streak of insanity may bear a child who will be a genius; a parent who is a great philosopher or poet or statesman may have a son who is an idiot. We can hardly guess what strain, itself abnormal, may be of greatest value when blent with a different strain in parenthood. The mechanism of heredity is so intricate that with our present knowledge we are hardly competent to meddle with it, when it is a question of producing such a complex result as moral endowment.

Finally, the attempt to interfere with parenthood to the extent necessary to produce any appreciable changes in the instinctive endowment of future generations would not for a moment be tolerated in our times. Would you acquiesce in enforced sterility because you have, say, a congenitally explosive temper? or because you have shown a callous selfishness in pushing under your business rivals? When we think of state interference with marriages in the interests of morality, we imagine, of course, that we personally should be selected for parenthood, while the poor unfortunates in prisons and poorhouses would be prevented from marrying. But it may well be that many of the prisoners in Sing Sing have better blood in them than you. Are you sure that if they had had your opportunities they would not have done better with them than you? or that you, under their temptations, and with their lack of good influences and training, would not have landed in Sing Sing? It is

true that a large proportion of prisoners and paupers and prostitutes are feeble-minded; we may agree to their segregation for life or sterilization. But to a large extent crime and vice are the result, under fostering influences, of tendencies which exist in us all. And if we have had reasonably happy lives in spite of moral defects, we prefer to risk parenthood and trust to our children to get along as well or better.

What then? Is there no hope for the acceleration of moral progress? Yes, there is much hope. But it lies in the improvement of the old methods of moral teaching and training. Morality is something acquired by each generation, and not something transmitted by parents to offspring; we can greatly facilitate its acquisition. Morality is functional, not organic; it results from the way we use our powers and direct our instincts, not from their inherent nature. But we are not trying on any large and systematic scale to provide competent training in the art of life for our youth. We employ experts to teach them Latin and mathematics; we see to it that they know how to build bridges properly if they are to be engineers, or fill teeth properly if they are to be dentists. But we leave the most important training of all, the training that shall show them how to guide their desires and instincts, how to avoid the snares and pitfalls of life, how to be steadily and honorably happy, to the haphazard attention of parents, who are for the most part themselves ill-trained and ignorant of how to live. We need not despair of the efficacy of moral training, for we have hardly begun to try it.

The churches and Sunday-schools do a good deal, but theirs is little more than a one-day-a-week influence, on a minority of the population; and that more or less distracted or obstructed by theological interests, and offered in terms often unassimilable. Moreover, the homilies of the preacher are usually more or less discounted; it is his "job" to exhort. The actual perplexing problems of living are seldom taken up in the churches and discussed in a free and unbiased manner. It is clear that in our present chaotic religious situation, with numberless sects offering divergent doctrines, and the work of teaching done mostly by volunteers, young men and women of no special training or fitness for the work, we can not expect the crystallization and maintenance of clear and generally accepted codes through the work of the churches alone. The great task of moral education must be undertaken by the schools.

Our educational system is fairly good on its informative side, and in the mental drill it provides. But in its moral training it is inexcusably deficient. What if our school-superintendents and college presidents were to recognize that the prime function of education is to alter habits of conduct? What if our school system were to seek from the beginning to impart an interest in right living, were to discuss concrete problems of conduct, and to quicken conscience, by the many methods

known to skilful educators? It could then turn out multitudes of boys and girls trained to a code, as knights were trained in former days to courage and chastity and the service of the weak. What if loyalty to school and college were to come to mean primarily loyalty to that code; so that for a Harvard man anywhere to be detected in lying would be a shame to the college, or for a Yale man to use unfair methods in business would be to make his classmates blush and brand him as untrue to his *alma mater*?

Sinners there will continue to be, no doubt. Our human heritage includes instincts that are rebellious against any restraint; and the best of moral training may, now and then, result in failure. But the difficulties in the way of a task are no excuse for not undertaking it. We must give our youth insight into the possibilities of right living; we must arouse their interest in learning better ways, their enthusiasm for ideals. In this moral education, rather than in eugenics, lies our real hope for the raising of the general standards of moral conduct.

THE PUNCHBOWL: HONOLULU'S METROPOLITAN VOLCANO

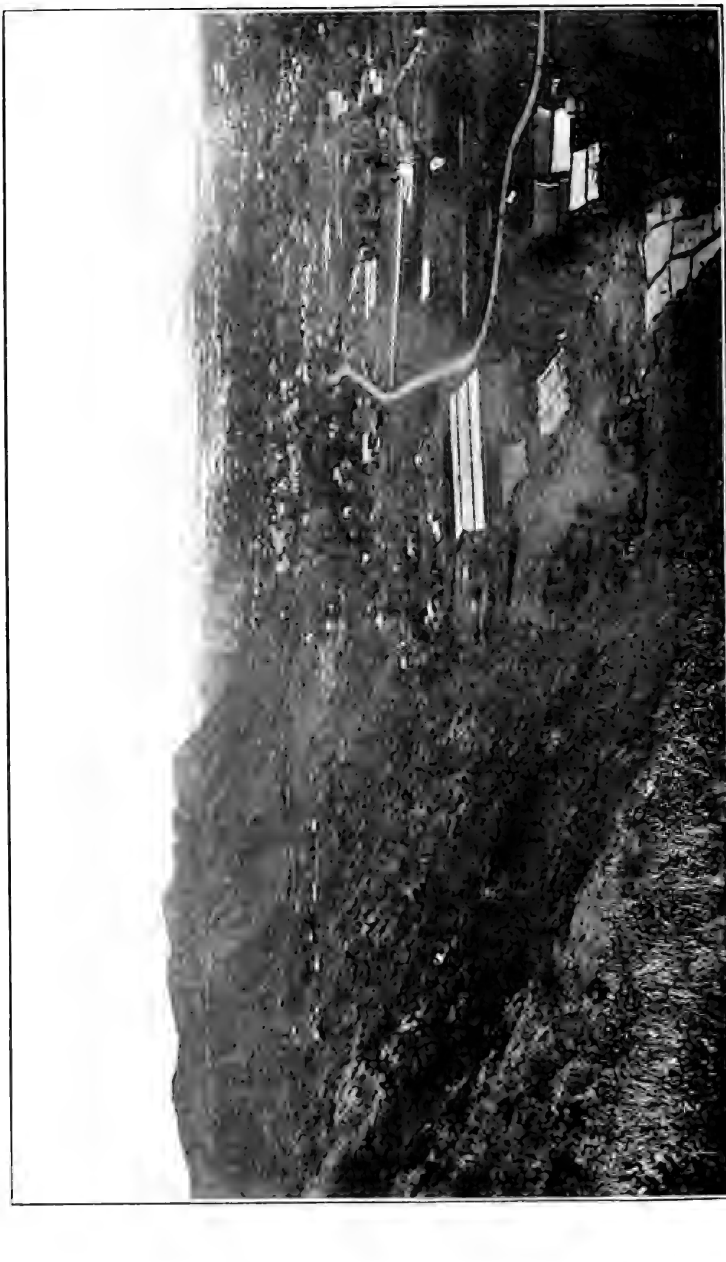
By VAUGHAN MacCAUGHEY

THE COLLEGE OF HAWAII

HONOLULU, capital of Hawaii and strategic center of the north Pacific Ocean, is widely known as a tropical tourist resort, and as a great American naval station. The city has spasmodically expanded from an aboriginal cluster of grass huts to a cosmopolitan metropolis of sixty thousand people. It now stretches loosely along eight miles of the narrow coastal plain which lies between the mountains and the sea. The plain is of coral origin and rests upon the submarine flanks of the deeply carved volcanic mass that forms the bulk of the island. Scattered here and there over the plain are numerous craters that were thrown up by the final convulsions of the plutonic island-builders. These igneous disturbances ceased long ago and apparently are extinct. The silent craters remain as grim testimony of Oahu's prehistoric epoch of fire. Among the best preserved of these crater-hills is old "Punchbowl," a remarkable volcano lying in the very heart of Honolulu and commanding a magnificent view of the city and its lovely environs.

The Hawaiian name for this venerable crater is *Pu-o-waina* and it has a tragic significance. The original form, from which the modern spelling is abbreviated, was *Puu o waiho ana,* literally the hill of offering or sacrifice. The people of primitive Hawaii were dominated by the dreadful *tabu* system that once ruled all Polynesia. The penalty for any violation of its intricate regulations was death. *Pu-o-waina* was one of the places near Honolulu where the bodies of the offenders were ceremoniously burned. Near the highest point on the seaward rim is a flat, altar-like ledge. Below this ledge is a crack or orifice, once a volcanic vent. This gave a good draft of air and added to the suitability of the place for a sacrificial altar. Like place-names in all parts of the world, *Pu-o-waina* lingers for generations after the extinctions of the practises that once made it so effective.

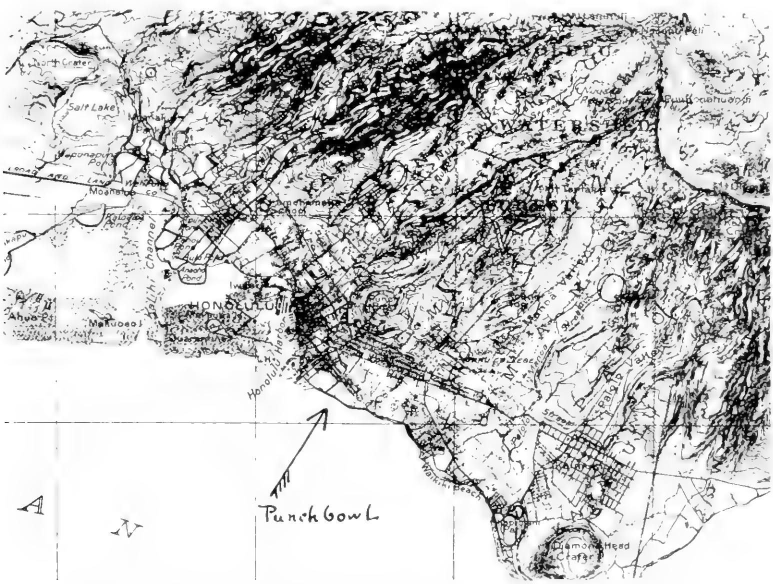
In shape and structure Punchbowl is a fine example of a truncated volcanic hill produced by explosion. By truncated is meant, not that its top was ever blown off, but that it never possessed a sharply conical point or peak. From the time of its formation its top has been a bowl-shaped depression. The crater walls are composed of brown volcanic mud or tufa, which was violently ejected in a single titanic explosion.



PUNCHBOWL CRATER AND HONOLULU, AS VIEWED FROM THE MOUNTAINS ABOVE.

The huge column of superheated steam-charged mud and rock-stuff tore through the soft coral plain, shot to dizzy aerial heights, and dropped back around its vent. Thus was produced the symmetrical rim and bowl, and hence the name Punchbowl. There are numerous extinct volcanoes on Oahu and other Hawaiian islands that were formed in this same manner, and that with equal appropriateness might claim the fanciful title of Punchbowl.

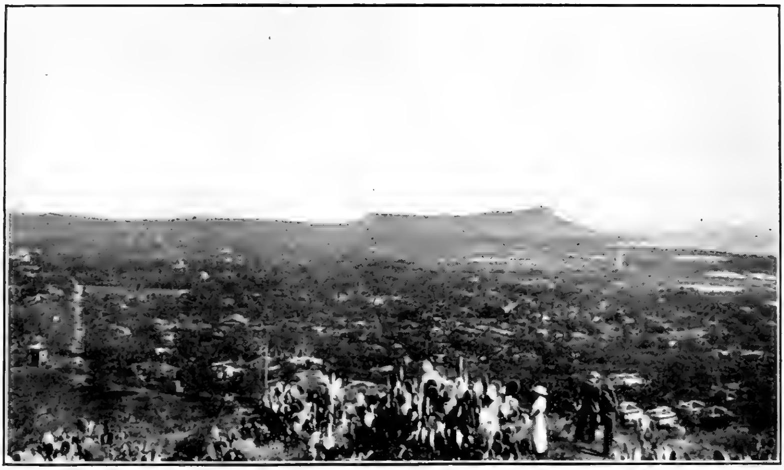
The elevated coral plain up through which Punchbowl exploded is here about fifty feet above sea-level. The highest point of the crater is about five hundred feet (498) above the sea. The total diameter of the hill, including the basal slopes, is a full mile. The "bowl" has a rim-to-rim diameter of 2,200 feet from north to south, and 1,800 feet from east to west. The marked difference in the two diameters is shared with the other Hawaiian volcanoes of this type and is due to the wind



Map of Honolulu, showing the Location of Punchbowl.

conditions that existed at the time of the eruption. The usual winds of this part of the North Pacific in which the Hawaiian Archipelago is situated are the well-known trade-winds. These blow steadily from the northeast practically throughout the year. The trade-winds are so constant that the majority of the explosive cones are conspicuously one-sided. The strong wind deflected the eruptive column of volcanic mud. Consequently the bulk of the ejected material was dropped on the leeward, or southeast, side of the vent.

Punchbowl, however, is a striking exception to this prevalent elongation of crater axis in the direction of the trade-wind. It so happened



VIEW FROM PUNCHBOWL ON THE LOWLANDS. Diamond Head in the distance.

that just at the time of the Punchbowl explosion the dominant wind was not the trade, but the southeast, or "Kona," wind. This Kona wind blows erratically at infrequent intervals, mainly during the rainy season. The configuration of Punchbowl clearly shows that a strong Kona wind warped the erupted column to the northwest, and caused the deposits to fall chiefly on that side.

Several excellent automobile roads cut spirally around the furrowed sides of Punchbowl, through low gaps in the crumbling rim, and finally circle the basin floor. The basin has a depth of about one hundred and fifty feet. Its monotonous interior is covered with a sparse and stunted growth of such thorny plants as prickly-pear cactus, lantana, algarona, and *klu.* The lower part of the basin, that benefits most from the scant interior drainage, supports a thin grove of the algaroba, or *kiawe,* trees. Cattle and goats roam freely through the crater. On several occasions the bowl has been surveyed as a reservoir site, but other more favorable localities have been chosen. Since the military occupation of Oahu by federal troops, the commanding position of Punchbowl has recommended it as a location for batteries. In the days of the Hawaiian monarchy several small brass cannon were mounted on the brow of the hill, but these were removed many years ago. The basin is now being used as a rifle-range by the local militia. The slopes may some day mask the formidable artillery of Oahu's coast defense.

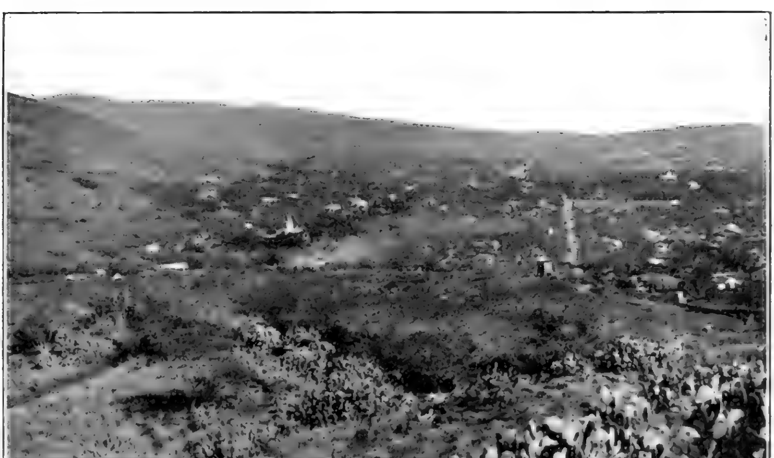
The outer slopes of Punchbowl are broadly scored by regular flutings or corrugations, the tooth-marks of long-continued erosion. These flutings and the numerous stone quarries make graphic sections and clearly reveal the structure of the walls. The tufa was deposited in well-defined layers of varying thickness, and permeated with coral lime. The layers strikingly show the double quaquaversal dip characteristic of volcanoes

of this class; their average angle is about twenty-five degrees. The quarries occur here and there along the lower skirts of the hill. The soft, easily-worked tufa has proved to be an excellent road material. Most of the streets and roadways in the vicinity are made wholly of tufa.

On the Punchbowl slopes one finds great quantities of a cinder-like volcanic ash. This is locally called "black sand." It occurs in extensive sheets over the Honolulu plain. The interior of Punchbowl crater is lined with this ash. A short distance eastward is a hill two hundred feet high, composed wholly of black sand. These evidences all point to a long series of stupendous black sand eruptions that devastated this region just as Vesuvius entombed Pompeii and Herculaneum. Some of the ash was ejected by Punchbowl, the remainder was discharged from other volcanoes in the neighborhood.

A very interesting glimpse into the geological history of Punchbowl has been afforded by an artesian well-boring near its flanks. The shaft first penetrated ten feet of black sand; then thirteen feet of *coral,* and finally about fifty feet of tufa. This succession shows that the crater was thrown up in relatively shallow water, coral reef grew over its flanks, and the reef in turn was covered by the volcanic ashes. The crater obviously was formed before the recent elevation of the Honolulu plain above the sea-level. According to Dr. Sereno E. Bishop the great symmetry and uniformity of Punchbowl's rim indicates that the crater was ejected in a *single rapid out-throw,* probably lasting a very few hours! He gives as the conjectural time of this explosion a period about 45,000 years ago.

Honolulu has steadily encroached upon the once-barren slopes of the volcano. In the early days Punchbowl was a remote outskirt, isolated



View from Punchbowl along the Lowlands at the Foot of the Mountains.

A STEEP TRAIL UP THE TUFA SLOPES OF PUNCHBOWL. The summit is 200 ft. above the observer.

by dry plains from the tiny grass-thatched settlement on the beach. To-day its base underlies an important residence section in the center of the city. The Territorial Normal School is located on its seaward slope. The thrifty Portuguese, skilled in the gardening of Madeira's steep farmsteads, settled as easily and comfortably upon the arid walls of Punchbowl as did the amphibious Chinese upon the marshy rice-lands. The small, well-pruned gardens of "Portuguese Town" are crowded with luxuriant trees and shrubbery—figs, pomegranates, citrus and mango trees, grape-vines, avocadoes, papaias, bananas, and many other useful and ornamental plants.

A superb panorama of the surrounding country is visible from the rim of this city-girt hill. The distant purple Waianæ Range, the Wahiawa pineapple lands, glimpses of Pearl Harbor and the Kalihi channel, bowery Honolulu reposing beneath its rich canopy of tropical foliage, the valley floors bright with rice and taro, the long ridges rising into the cloud-capped mountains, the friendly palms of Waikiki beach, old Diamond Head bleached and gray against the brilliant blue of the seaward sky, the rusty red Kaimuki region, and, mountainward, the forested slopes of Tantalus: these compose a variegated picture of unique and lasting charm.

Equally rich and memorable is a tranquil moonlit evening on Punchbowl's rim. The gaunt, moon-bathed crater walls fade into the twinkling scattered lights of the city; the hushed air throbs with the roll of distant surf; the odorous trade-wind pours down from the shadowy mountains; tropic fragrances rise from the white-fenced gardens; these quiet beauties, subtly blended by the moonlight, bring a new appreciation of this ancient hill of fire and sacrifice.

THE PROGRESS OF SCIENCE

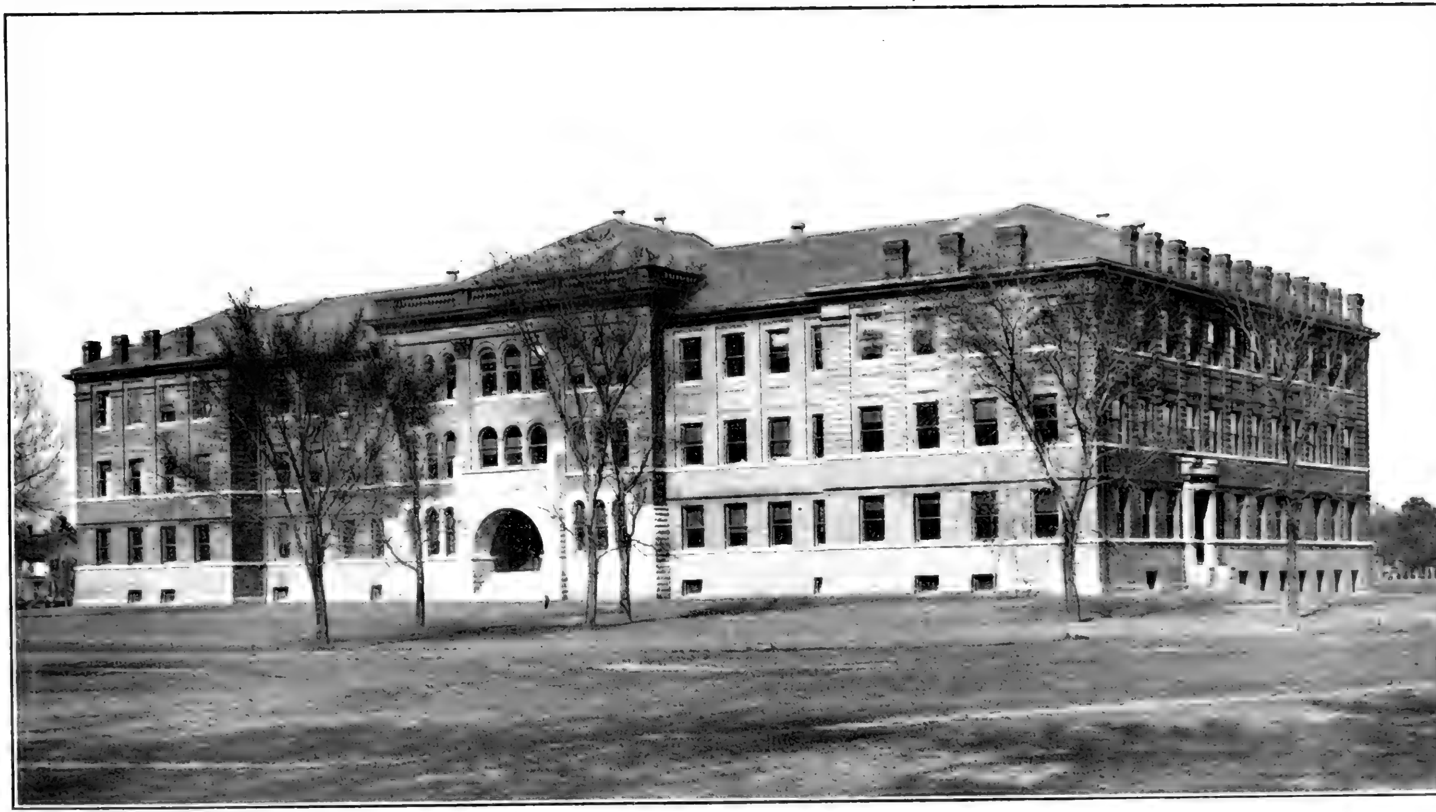
THE AMERICAN CHEMICAL SOCIETY AND THE CHEMICAL LABORATORY OF THE UNIVERSITY OF ILLINOIS

THE fifty-second meeting of the American Chemical Society was held at the University of Illinois, Urbana-Champaign, April 17–21, 1916. The meeting stands as the largest in the history of the society, the registration showing an attendance of 572 members and 157 guests, representing 32 states and 4 foreign countries. The two special features of the gathering were the dedication of the new chemical laboratory and an exhibit of American-made chemical products and apparatus. Excursions were made to the various departments of the university and to the chemical manufacturing plants at Danville. The entertainment included a review of the University Brigade of 2,100 men; a band concert by the First Regiment Band of 75 pieces; a smoker, and a banquet at which 402 covers were laid. Special entertainment for the ladies included receptions, concerts, luncheons and automobile drives.

At the council meeting the most important items of business were authorization of the publication of the ten-year index to *Chemical Abstracts,* and the appointment of a committee to consider the establishing of a publicity bureau whose duty it shall be to supply correct information of a chemical nature to newspapers and popular periodicals.

The first general session was held in the university auditorium, with Professor W. A. Noyes, chairman of the Illinois Section, presiding. President Edmund J. James, of the university, gave a cordial welcome to the visiting chemists. Professor Charles H. Herty, president of the society, responded in

THE FIRST BUILDING OF THE UNIVERSITY OF ILLINOIS. From a photograph taken about 1875. The Department of Chemistry was located in the basement of the rear wing, one window showing, just at the left of the shed. The only source of heat was a kitchen stove and water was supplied from a nearby pump.



The Chemistry Building, 1902.

HOME OF THE DEPARTMENT OF CHEMISTRY FROM 1878 TO 1902. This building, much changed in appearance, is the present Law Building.

an address in which was emphasized the need of trained chemists in the development of our national industries.

Sectional meetings were held in which a total of 283 papers were offered. These were distributed as follows:

Agriculture and Food	22
Biological	76
Fertilizer	1
Industrial and Engineering	26
Organic	53
Pharmaceutical	15
Physical and Inorganic	62
Water, Sewage and Sanitation	28

Two illustrated public lectures were delivered upon the subject of radium: Dr. Charles L. Parsons spoke on "The Production of Radium" and Dr. Curtis F. Burnam on "The Use of Radium in Treatment of Cancer."

The exhibit of chemical industries, arranged in the basement of the new building, proved to be one of the most interesting and valuable features of the gathering. Exhibitors to the number of 57 displayed a great variety of products of American manufacture, illustrating both the wide range of products of American ingenuity and the necessity for the development of certain other lines of chemical industry.

The dedicatory exercises were held in the university auditorium on Wednesday afternoon, with W. L. Abbott, president of the university board of trustees, presiding. In the opening address President James called attention to the fact that a university is no longer considered complete when it consists of a log with a teacher at one end and a student at the other; but a large factor in the success of a university in these days is the appearance of its campus and the equipment of its departments. The size and beauty of the new chemistry building at Illinois is an inspiring witness of the importance of chemistry.

"The Training of Chemists" was the subject of a very thoughtful and helpful address by Professor Alexander Smith, of Columbia University. All advancement in the science depends upon research and successful research requires thorough training. The entire chemical course should have all its instruction as well as the arrangement and equipment of the laboratories point toward greater efficiency of the chemists.

Dr. W. R. Whitney, member of the United States Naval Board, in a stirring address on "Research as a National Duty," told his hearers that he was tired of seeing the United States play the part of a trailer among na-

THE CHEMISTRY BUILDING, 1916. View from the tower of University Hall, looking southeast. In the foreground is the old portion of the building; the fire wall separating the new part is shown on both the north and the south portions of the roof.

tions; that leadership must come through systematic and thoughtful scientific research. Progress has been slow because we are just beginning to appreciate the value of research. Many of our institutions of learning are better known for their footwork than for their headwork. Colleges and universities must take the lead in research, for there is no better type of preparedness than research which is effective and persistent.

Upon the opening of the new laboratory, the department of chemistry occupies its fourth home since its organization in 1868. The first quarters were in the basement of the rear wing of the first university building, where heat was supplied from a kitchen stove and water was obtained from a near-by well. In 1878 the department was provided with a separate laboratory, a three-story brick building which is used now as the home of the College of Law. A much larger building was erected in 1902 and this building which is shaped like the letter "E" forms a part of the present completed structure. The present building forms a hollow square, 230 feet by 116 feet, the main lecture room and the machinery for ventilation being in the court. The working space comprises 3.77 acres. Each laboratory is distinctive in that its arrangement and equipment are planned for its own peculiar type of work. Abundant provision is made for research in various lines of work. The present valuation of the entire plant, including equipment and supplies is about $540,000.

THE HYPOTHESIS OF AVOGADRO

THE molecular hypothesis of Avogadro was proposed in 1811. Eight years before, John Dalton had put forward the atomic hypothesis, which bears his name, to account for the laws of definite and multiple proportions and the law of combining numbers. According to this hypothesis, an atom is the smallest particle of an element

which can enter into or be expelled from chemical combination. If the attempt is made, however, to determine the "smallest combining weight" of an atom, the theory shows itself to be defective in that it lacks a standard for fixing the atomic weights of the different elements. In 1808 J. F. Gay-Lussac had observed that when two gases react chemically, the volumes which react bear a simple ratio to one another and to the volume of the gaseous product of the reaction. It follows at once if elements in a gaseous state unite in simple proportions by volume, and if the elements also unite in simple proportions by atoms, then the number of atoms in equal volumes of the reacting gases (at the same temperature and pressure) must be simply related. But even so, we still have no means of determining the numerical value of this relation, and therefore can not use the discovery of Gay-Lussac as such to determine relative atomic weights.

Avogadro (1811) went one step further in suggesting that this volume relation pointed out by Gay Lussac is the simplest possible, viz., *equal volumes of all gases, at the same temperature and pressure, contain the same number of ultimate parts, i. e., molecules.* A distinction is made between the elementary atoms and the small particles of a gas. Assuming that the small particles of a gas are aggregates of a definite number of atoms, Avogadro called these aggregates molecules, to distinguish them from the ultimate atoms. Avogadro thus modified the atomic hypothesis and adapted it particularly to gases. The hypothesis of Avogadro has been confirmed by such an abundance of subsequent work that it is now placed among the well-established laws of chemistry and physics. The same hypothesis was announced independently by the French physicist Ampère in 1814. By Avogadro's hypothesis equal volumes of gases contain the same number of molecules, consequently, the relative density of a gas is proportional to its molecular weight. The determination of the relative molecular weight of a gas is thus reduced to a laboratory measurement—the determination of the relative density of the gas.

After the proposal of Avogadro's hypothesis efforts were made to work out a reliable system of atomic weights; but chemists persisted in using and abusing the terms, "atomic weight," "combining weight" and "molecular weight" in every conceivable way, with the result that rank confusion prevailed in chemical literature. The confusion was increased by the attempt of Avogadro to apply the hypothesis to substances which could not be vaporized. This state of affairs led ultimately (1840) to the abandonment of the hypothesis by most chemists. Only Avogadro and Gaudin accepted it but without furnishing further evidence.

In the forties, however, a new epoch was begun in the history of Avogadro's theory, when Gerhardt recognized its value for the determination of formulas. Among the first to adopt the views of Gerhardt was Laurent, and these two men worked together earnestly for a period of about ten years, with the result that more and more attention was given to their views. At the death of these men in the early fifties, the work devolved upon the younger chemists—Cannizzaro and Kekulé. It was Cannizzaro who finally (1860) cleared up the confusion by showing just how the molecular hypothesis could be used to solve the problem of the relative weights of the atoms. Cannizzaro pointed out very distinctly the difference between atoms and molecules—"equal volumes of gases, whether they be simple or complex, contain an equal number of molecules, but not an equal number of atoms"—and proved that the molecular hypothesis was in harmony with all known facts. In addition, Cannizzaro called attention to the fact that Avogadro was the first to suggest this hypothesis. At the Congress of Chem-

ists at Carlsruhe in 1860, due largely to the initiative of Kekulé, Cannizzaro played a leading rôle. Lothar Meyer said (1860) after reading Cannizzaro's pamphlet, "the scales fell from my eyes, my doubts disappeared, and a feeling of tranquil security took their place." And while the hypothesis of Avogadro still remained a subject of controversy for some years, the day was won.

THE AVOGADRO MEDAL AND THE WORK OF PROFESSOR MORSE

In 1911 an international congress of scientists met in Turin, where Avogadro was formerly a professor in the university, for the purpose of celebrating the hundredth anniversary of the famous "Hypothesis" and of honoring the memory of its author. Out of the funds contributed for the occasion 1,500 Lire were set aside for an "Avogadro Medal" to be awarded, during the year 1915 or soon thereafter, by the Academy of Sciences of Turin, to the one who in its judgment should have published during the three-year period, 1912–1913–1914, the most notable contribution (experimental or theoretical) in the domain of molecular physics. It was this medal which was awarded at a meeting of all the sections of the Accademia Delle Scienze Di Torino on February 6, 1916, to Professor H. N. Morse, of the Johns Hopkins University, for his work upon "The Osmotic Pressure of Aqueous Solutions." This investigation was begun, after considerable tentative study of the problems to be solved, about 1899, and it has since been carried out under the auspices of the Carnegie Institution of Washington. A report on the progress of the first fourteen years of the work is given in Publication 198 of the Institution.

It is impossible to give in the space available any adequate outline of the investigation of Professor Morse and his co-workers, Drs. Frazer and Holland; but a few brief statements may be useful by way of orientation. In 1877, W. Pfeffer, then professor of botany at Basel, published under the title "Osmotische Untersuchungen" an account of his endeavors to measure osmotic pressure by means of porous cells lined with a "semi-permeable" membrane consisting of potassium ferrocyanide. The phenomena described by Pfeffer were impressive, and his quantitative results were accepted as at least approximately correct. He attempted the measurement of very moderate pressures only, and the concentration of his solutions was given in percentages. No one seems to have concerned himself about the *molecular* concentration of Pfeffer's solutions until 1887 when Van't Hoff published his epoch-making conclusions regarding the analogy between gas pressure and the osmotic pressure of solutions. Van't Hoff's conclusion that the latter would be found to obey the laws of Boyle and Gay-Lussac for gases was based, in part, on the recalculated results of Pfeffer's experiments. To chemists the way now seemed clear to a satisfactory experimental study of the molecular condition of substances in solution; *for it was only necessary to measure their osmotic pressure, and, apparently, Pfeffer had shown how this could be done.* Probably in nearly every working laboratory in the world attempts were soon made to repeat the experiments of Pfeffer as a preliminary to the investigation of solutions through their osmotic pressure; but every such attempt failed.

All serious attempts to measure osmotic pressure directly were soon abandoned, except by Professor Morse and his co-workers. The reason why all previous investigators (himself included) had failed to attain even to the partial success of Pfeffer, and why Pfeffer himself had not obtained better results, is shown in his chapter on "Membranes." A fundamental condition of success in the direct measurement of osmotic pressure is found to be that the semi-permeable membrane shall

consist exclusively of "plugs driven with great force into the mouths of the pores of the cell wall where they open upon the surface of the space occupied by the solution." But how were these "plugs" to be driven into place with such force that no pressure can displace them? The solution of this problem was the electrolytic method of depositing semi-permeable membranes which was devised by Professor Morse, and which is now the only method in use for the building up of osmotic membranes.

It was necessary, however, in order that deposition occur in exactly the right positions, namely, just within the inner mouths of the pores, to secure a texture of porous cell wall of a hitherto unknown degree of fineness. The requisite degree of uniformity and fineness of texture of porous cell wall was finally obtained, after four years of experimental work with clays from many sources. After developing to a high degree of precision all phases of the method, the formal measurement of osmotic pressure was begun. The most striking conclusions to be drawn from the results to date are: (1) that the magnitude of osmotic pressure in aqueous solutions depends on the *numerical ratio* of the solute to the solvent molecules; (2) that the laws of Boyle and Gay-Lussac for gases hold good for the osmotic pressure of solutions, but in a different sense from that supposed by Van't Hoff. According to Van't Hoff, and most others, a gram-molecular weight of a substance dissolved in water and diluted to a liter volume should, at zero degrees, exert an osmotic pressure of 22.26 atmospheres, the same pressure which an equal quantity of gas exerts at the same temperature when its volume is reduced to one liter. This is not true. It is true that if a gram-molecular weight of a substance is dissolved in 1,000 grams of water at zero degrees, and no hydration occurs to change the numerical ratio of solute to solvent molecules, the osmotic pressure of the solution will be found to be 22.26 atmospheres and at any higher temperature it will be what the law of Gay-Lussac would require.

SCIENTIFIC ITEMS

We record with regret the death of Dr. Lucien Ira Blake, formerly professor of physics and electrical engineering at the University of Kansas; of Dr. James William White, emeritus professor of surgery in the University of Pennsylvania, and a trustee of the university; of Dr. William Frederick King, chief astronomer of the Canadian government; of Professor F. Schenck, the director of the physiological institute at Marburg, and of M. Octave Lignier, professor of botany at the University of Caen.

Members of the National Academy of Sciences have been elected, as follows: Gregory Paul Baxter, professor of chemistry, Harvard University; Gilbert Ames Bliss, professor of mathematics, University of Chicago; Marston Taylor Bogert, professor of organic chemistry, Columbia University; Otto Folin, professor of biological chemistry, Harvard Medical School; Leland Ossian Howard, chief of the Bureau of Entomology, U. S. Department of Agriculture; Phoebus Aaron Theodore Levene, member in biological chemistry, Rockefeller Institute; Alfred Goldsborough Mayer, director of the department of marine biology, Carnegie Institution; Raymond Pearl, head of the department of biology, Maine Agricultural Experiment Station; Frank Schlesinger, director of the Allegheny Observatory, University of Pittsburgh.

The Royal Society has elected as foreign members: Prince Boris Galitzin, head of the Russian Meteorological Service; Dr. C. L. A. Laveran, of Paris, discoverer of the malarial parasite; Dr. Johan Hjort, director of Norwegian Fisheries; Professor Jules Bordet, the bacteriologist of the University of Brussels, and Professor H. Kamerlingh-Onnes, professor of physics at Leyden.

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